(A WORKSHOP ON RESOURCE INTEGRATION FOR WILDLIFE AND FOREST MANAGERS)

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a workshop on resource integration for wildlife and forest managers

Prince George, B.C.

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Doug Kelly
Dave King
Jim Pojar
Ian Moss, Chairman

These proceedings are a testament to your commitment to integrated resource management in this most beautiful landscape.

PREFACE

Integrated Management and its predecessor, multiple use, have been the subject of conferences, newspaper columns, academic texts, casual discussions and heated debates for decades. Indeed, this was the theme of the first conference I attended as a professional more than twenty-five years ago. The continuing discussion reflects both our present failure to integrate the management of forested ecosystems and our collective determination to struggle toward that objective.

Within British Columbia, because of the great diversity of the resource base and its largely public ownership, this determination is most pronounced, particularly among line managers working at the field level. There, personal commitments to protect the resource base, the advice of colleagues in related disciplines, obligations to employer, to family, and to the community in which one lives can diverge to such an extent that they create levels of stress that are seldom, if ever acknowledged. To cope,the most timid among us retreat between the covers of a policy manual. Others, more aggressive but overcome by the difficulty of integrated management, adopt an adversarial stance, often encouraged by the mandate under which they labour. The most innovative seek solutions. For these individuals, the growing public criticism of the state of the resource base, and consequently, their performance as professionals, is just not acceptable.

The conference recorded here was conceived and organized by the innovators. Speakers and delegates were practising professional foresters and biologists of similar persuasion, almost all from a single jurisdiction, British Columbia. The overall objective was to try to identify factors limiting efforts to integrate the management of forests for both timber and wildlife. To reach the objective, the meeting was structured as a symposium/workshop.

The symposium describes initiatives and provides current information on topics ranging from policy and administrative tactics, through the nature of wildlife habitats and their inventory, recent advances in the synthesis and display of information, to a case history of successful integration. These papers form the bulk of this publication which tends, therefore, to mask the relative importance organizers attached to the workshop. That is, the symposium was intended to set the stage for a workshop which was focused on our primary objective; the identification of changes in policies and procedures which would remove factors presently limiting the efforts of field foresters and biologists to integrate the management of forests for timber and wildlife. For this reason a synthesis of the results of the workshop appears as the initial paper in these proceedings.

Seldom seen in a document such as this is the overwhelming importance of the attitude of individual resource managers. Here, happily, this critical ingredient for successful integration is visible. Young, in the final paragraph of his "Historical Perspective" makes it explicit. Its importance is reinforced, either explicitly or implicitly in the papers by Greenfield, Demarchi, Melenca, Hebert, Flinton, and Clark. It emerged as well in the workshops and consequently appears in their summary, together with a number of recommendations identified by workshop participants which we hope will attract the attention of policy makers and others interested in moving toward integrated management of forests for the production of timber, wildlife and indeed the range values found in forested ecosystems.

Alan Chambers

OPENING REMARKS

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Welcome: wildlife biologists, foresters, hunters, photographers, trappers, guides, natives, ecologists, naturalists, loggers, developers, journalists, democrats, autocrats, advocats, NDP'ers, Socreds, researchers, managers, students, teachers, traditionalists, futurists .... How can we best integrate wildlife and timber production? To begin with, each of us could adopt the following ethics;

1 We will expand our personal knowledge regarding the value of different wildlife species and habitats, the value of timber and ultimately the value of biodiversity.

2. We will strive to expand forest management strategies and techniques for the purpose of protecting and enhancing biodiversity and wildlife and timber resource values.

3. We will strive to apply forest management strategies and techniques for the purpose of protecting and enhancing biodiversity and wildlife and timber resource values.

4. We will openly share with others our opinions and information regarding resource valuation and management options.

5. We will respect each others opinions as much as our own.

6. We will act to protect and enhance biodiversity and wildlife and timber resource values.

The challenge for the 1990's is for each of us to adopt these ethics in our day-to-day activities, regardless of our job descriptions or areas of specialization. We must look to ourselves, as individuals, for answers to the question, "How can we best integrate wildlife and timber production?". It is our individual responsibility to improve the integration of wildlife and timber resources: ingnorance is no excuse for failure to act or comply; it's not the other guy's fault; we can't stop the world and get off; we can't refuse to become involved while ridiculing others or "the system". We must quit playing loophole with our agreements: you'll have to prove it before I'll change; that was my predecessors fault; or, whoops - I'll do better next time. Integrated resource management must take top priority in our day-to-day business in spite of our fields of

specialization or "expertise".

How can we best integrate wildlife and timber production? What is integrated management? How do we know when we've achieved success? What kinds of information are required to better integrate wildlife and timber production? What administrative processes will help to ensure that the job gets done? What planning processes are required to help us clarify the range of management options and where such options could be applied? Who should make the final decisions when we can't agree? These are questions that will addressed over the next two days.

The challenges for each of us during this symposium are to participate, to listen and to learn. Our goal is to develop both individual and collective strategies that will enable us to better integrate wildlife and timber production in our day-to-day work after this symposium is over.

Good luck in meeting the challenges and achieving the goal. Thank-you for helping to make this symposium a success.

WORKSHOP SUMMARY

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INTRODUCTION

Solutions to problems in industrial management are, more often than not, found by managers listening to workers on the shop floor. That is a frequent message of articles dealing with industrial management appearing in a variety of trade magazines, newspapers and professional journals. The major premise underlying the workshops summarized here is that this principle is general; that it applies to resource management problems as well as manufacturing or indeed, problems that develop in any organization.

That there is a problem with the management of British Columbia's natural resources is not in dispute. Many, if not all professional biologists and foresters attending this meeting are convinced that the production of wood and wildlife from the forested landscape can be integrated to a much greater degree than is currently practised. Collectively, these individuals are deeply concerned with the intensity and pitch of public criticism of their performance. Perhaps more motivating is the internal conflict which many have felt for longer than it has taken for public discussion to reach its present level. It should surprise no-one that field level foresters and biologists were among the first to become aware that the management of forested ecosystems for the production of timber, wildlife and a range of other values should, for the benefit of all these resources, be integrated much more than conventional practise allows.

The workshop reported here sought to tap the extensive experience of field level personnel for the identity of policy, administrative, and other changes which would remove obstacles which they perceive to be limiting or inhibiting the practise of integrated resource management. Registration for the workshop is summarized in Table 1, which confirms that well over eighty percent of those attending work directly with the timber and wildlife resources of British Columbia.

WORKSHOP STRUCTURE

Participants were assigned to working groups of about a dozen individuals to address the question: How can we best integrate wildlife and timber production? Organizers made a deliberate effort to distribute biologists and foresters evenly among working groups so that both public and private sector as well as timber and wildlife perspectives were present in each. And because most of the individual participants were known to the organizers, an effort was made to place the more dominant or

forceful personalities together. That is, the assignment of individuals to working groups was governed by a search for balance. Finally, a facilitator was assigned to each group to promote discussion, encourage the expression of alternative points of view, and to prepare a summary of major points made during a three and one half hour workshop session.

Table 1. SYMPOSIUM/WORKSHOP REGISTRATION BY EMPLOYER

B.C. Ministry of Forests	86
Industrial Foresters	71
B.C. Ministry of Environment	28
Industrial Wildlife Biologists	5
Consultants	17
Alberta Forest Service	7
Alberta Fish and Wildlife	2
B.C. Ministry of Parks	5
Wildlife organizations	2
Forestry Canada	2
Teachers	2
Students	3
TOTAL	230

To offer some uniform structure for the individual workshops, six subject areas were identified although it was stressed throughout that participants were free to redirect their diliberations if they felt it would be more constructive or fruitful to do so. The six subject areas offered were as follows:

WORKSHOP QUESTIONS/SUBJECT AREAS

HOW CAN WE BEST INTEGATE WILDLIFE & TIMBER PRODUCTION?

1. Ice Breaker

   Why did you come to the workshop and what do you hope to achieve?

2. The Vision

   What is successful integration of wildlife and timber and how do we know when we have achieved success.

3. Information Requirement

   What wildlife and timber information is needed to develop effective integrated resource management plans and what information is lacking?

4. Administrative Framework

   Who should collect the information necessary to make informed decisions; who should be responsible for meeting and implementing integrated resource management decisions and who should pay?

5. Planning Process

   What processes or mechanisims will most effectively integrate forestry and wildlife management concerns into:

   (a) Integrated Resource Management (ie TSA Plans).

   (b) Operational Plans: Development Plans, Pre and Post-harvest Silvicultural Prescriptions

6. The "Hammer"

   When conflicts between resource managers become seemingly insoluble, what conflict-resolution mechanisms or appeal procedures should be available or applied? What is the nautre of these conflicts: How should the final decision be made? Who should make them?

At the conclusion of the individual workshops, a short plenary session was held to present and compare four of the facilitators summary statements, and to explore the possibility of some consensus statement from the entire gathering.

DISCUSSION AND RECOMMENDATIONS

The value of the final plenary session is extremely difficult to capture. Had we drafted a preliminary statement with the individual facilitators for presentation, discussion, and modification during the plenary, the attempt to reach a comprehensive concensus may have been more successful. With only the hastily prepared notes of four facilitators and the brief time available, the meeting did agree that a synthesis of the individual workshop summaries should be prepared for transmission to the British Columbia Forest Resources Commission, and that present staffing levels in both the Ministry of Environment and the Ministry of Forests were too low to cope with the required workload.

The latter conclusion is, in retrospect, both predictable and unfortunate. It is predictable because, when pushed for a quick consensus, any gathering will easily agree that "we all need more". It is unfortunate because such conclusions, presented in the absence of detailed justifications, seldom find a receptive ear. Yet there is substance behind the request that deserves the careful attention of both our politicians and their advisors, most notably the B.C. Forest Resources Commission.

> **Field Foresters must frequently plan and execute timber harvesting and silvicultural operations with inadequate advice and information regarding wildlife populations and their habitiat requirements. Must, because the rate of timber harvest required to maintain the forest industry exceeds our ability to account for wildlife requirements as harvesting and silvicultural operations proceed.**
>
> **AND**
>
> **Field biologists are expected to manage wildlife populations with no jurisdiction and very little control over the supply of food, cover, and other conditions necessary for the reproduction, growth, and development of these animals.**

While an increase in the number of field biologists would improve access to existing wildlife information, that in itself is insufficient to integrate the production of timber and wildlife from forested ecosystems. The workshops identified a number of tactics that are equally, if not more important.

It should be noted here that the task of distilling and synthesizing the meaning of notes taken in eighteen concurrent workshops or discussion groups is formidable. In the following recommendations I have tried to faithfully reflect the intent of the discussions recorded in these workshop notes, expanding where I considered it necessary to clarify for readers not initmately familiar with the problem, its antecedents and causes.

WORKSHOP RECOMMENDATIONS

1. Focus the problem of integrated management geographically

Without exception, the workshops agreed that there is an urgent need to define the land base from which at least some timber is to be produced. The current call is for a Provincial Land Use Strategy. This "strategy" is generally seen as a policy, approved legislatively, requiring hinterland zoning for priority uses and the establishment of production targets for wildlife, timber, and perhaps other values. That is, to identify areas where we <u>are</u> going to harvest timber, rather than areas where we are not.

One objective of the "strategy" is to reduce the level of uncertainty inherent in the present system of allocation. The forest industry in this province was founded on assumptions concerning the availability of land and timber that are no longer valid. For example, large areas of forested land, once considered the exclusive domain of the developing forest industry, now lie beneath hydroelectric reservoirs, within parks, wilderness conservancies, areas now known to be too sensitive to harvest, or have been cleared and developed for agricultural purposes. A number of initiatives for additional "withdrawals" of forest land are currently under discussion. The positive response of government under these circumstances is to explictly identify the land base which will be available to support the industry in the coming decades.

Recognizing that new information and evolving social values will require subsequent changes in land allocations, several workshop groups anticipated the need for a well structured and clearly defined process through which these changes can be made. The uncertainty associated with the present ad hoc or unstructured process is, quite simply, unacceptable.

A second objective of the "strategy" is to provide a clearer focus for integrating production targets, together with plans and prescriptions for reaching them. Few, if any participants, anticipate the "strategy" to identify much, if any, single use timber land, but rather a grouping of compatible uses, such as wildlife and timber production, within which they can establish achievable goals. Said another way the "strategy" as it is generally perceived, will not only identify the industrial forest land base, but also make explicit the mix of resources for which it is to be managed.

In considering this recommendation for province wide land use planning, authorities should note that participants agreed the implimentation of their "strategy" would impact upon the allowable annual cut of timber. While some considered that the timber harvest could be increased under such a regime, others anticipated a decrease. This variation in anticipated impacts upon the annual allowable cut is almost certainly related to variations in the amount of land participants expect would be identifed for "single use" timber production, and the intensity of silvicultural practises which could therefore be applied to it. While this discussion clearly illustrates the adoption of a "land use strategy" would not remove all disagreements between timber managers and wildlife biologists, there was consensus that the above "strategy" was necessary to promote integrated management for timber and wildlife

and reduce the uncertainty which currently plagues both timber and wildlife interests.

2. Adopt common administrative and planning unit boundaries

Although inherent in the land use strategy recommended above, a system of administrative and planning unit boundaries common to all resource agencies is recommended separately since this request was made repeatedly in individual workshops. To emphasize, it is sometimes necessary for a single office of one agency to work through as many as three offices of another because of differences in present administrative boundaries.

While all workshops did not address the question of scale, a number of groups did suggest that management should be integrated at four levels of increasing detail, namely, provincial, regional, timber supply area, and finally, at an operational scale. Within these administrative boundaries, inventory, prescription, and monitoring activities would be most effective if applied to units defined by ecological parameters.

3. Replace the present, reactive, referral system with a proactive, integrated resource management planning process

The most innovative and important recommendation of the workshops was that the presently reactive referral system be replaced with a proactive integrated resource management planning and management process. This recommendation has the potential to dramatically improve both the management of the provincial forest land base and the public's perception of that management. That there was consensus among such a large group of field foresters and biologists regarding the general nature of this change punctuates its importance.

While there were variations in detail from one group to the next, the process was generally seen to have the following characteristics:

i) it operates at the four levels or scales of administration recommended above, (operational, local (or TSA), regional and provincial).

ii) production targets or objectives for each resource are established from the outset, at the TSA level, and by the planning team.

iii) planning teams ae comprised of equal partners who carry with them the authority to commit the agency, company, or organization which they represent to the agreed upon course of action.

iv) decisions are made by consensus, or, when consensus cannot be reached, are passed to the planning level immediately above. There is no benevloent despot below the level of Cabinet. Decisions are not made by a majority vote, but by consensus.

v) planning teams are comprised of "all stakeholders". That is, particularly at the local and operational levels, the process is seen as one involving not only the resource agencies, but also individuals, companies, and/or organizations having a vested interest in the outcome.

vi) plans are sufficiently open and flexible that they can be adjusted in response to continuous monitoring of the resource base.

vii) both the process and plans are accessible to the public.

Some participants suspected that the mandates of individual resource agencies may have to be revised to establish a planning and management process such as that sketched above. For example, the MOE mandate may need to be expanded to include responsibility for wildlife habitat, as well as the animals themselves. Others suggested that a memorandum of understanding signed by the ministers and deputy ministers of participating ministries would serve as well, and would in fact establish an example of the proactive, cooperative atmosphere necessary for such a system function effectively. Whatever tactic is chosen, its objective is to clearly establish wildlife, and indeed all agencies, as equal partners in the planning process.

4. Promote the development of skills and attitudes necessary for teamwork among resource management specialists

Emerging from the workshops were a number of comments and suggestions collectively identifying the increasing importance of teamwork among resource management specialists. These suggestions were changes to the curriculum of foresters and biologists that would promote interaction during their years of study, and ideally, begin to produce specialists with attitudes and skills necessary to manage ecosystems rather than timber, or wildlife . And because of the steadily increasing demand of the public for both information and opportunities to interact with field personnel, an increased emphasis, in professional curricula and professional development programs, on the development of communication skills was considered important by a large number of participants. Indeed, had there been time during the final plenary to ask for a response on this point, there is little doubt that a consensus would have emerged almost instantly.

5. Provide additional funding to upgrade wildlife habitat inventories

During or plenary session, considerable discussion focused on the need for additional staff, particularly in the area of habitat biology, the need to upgrade the forest inventory and the need for people to respond to growing public demand for information. In sum, the sense of the meeting was that while it felt all were required, the greatest shortfall, at present, is in the area of habitat inventories.

The meeting was well aware of the government's determination to control costs,

and of its frustration with current public criticism of natural resource management in the province. Recognizing that it is in everyone's interest to reduce the criticism, participants sought the most cost effective ways to achieve this objective in an atmosphere that can only described as constructive. The request for increased funding was not made lightly.

That a group of 230 people with such varied backgrounds and work environments reached concensus on so many points in such a short time is truly remarkable. But perhaps the most poignant comment with which to conclude this all too cyrptic summary of our deliberations came close to the end of our meeting from a member of the B.C. Trappers Association: "I don't care who does it, the Ministry of Forests or the Ministry of Environment. I'd like the whole group here to just do something!"

We sincerely hope that the B.C. Forest Resources Commission and all Provincial policy makers will agree.

INTEGRATED RESOURCE MANAGEMENT IN BRITISH COLUMBIA - AN HISTORICAL PERSPECTIVE

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ABSTRACT

Integrated resource management has been advocated by many people for more than 50 years. While some of these individuals held influential and high ranking posts, their ideas were never translated into practise. Progress in integrating the management of fish, wildlife, timber, and other resource values has been the result of field initiatives by a very few visionary people who were willing to take the necessary risks. In the absence of policies and procedures which both legitimize and support these initiatives, individuals with the balanced perspective so necessary for integrated management were the first casualties in the ongoing land allocation/resource use conflict.

INTRODUCTION

I appreciated the invitation to present an historical perspective of integrated resource management in British Columbia during the "Ye Olde Haywyre Dayes" of yesteryear.

I plan to pattern my comments today around four main eras:

1. The Years of Emerging Vision - (But No action)
2. The Baseline years - (But Still No Action)
3. The Development Years - (The Stirrings of Action)
4. The Current Years - (The Dilemma).

THE YEARS OF EMERGING VISION - (BUT NO ACTION)

Surprisingly, early records in British Columbia are not devoid of nobel rhetoric, speeches and policy statements on the virtues and benefits of integrated resource management in British Columbia.

Let's look at two of these:

> "Of late, we have heard consideration of the multiple use of forest areas, in which recreational use is being stressed. It has taken us a long time to recognize the economic soundness of multiple use and the value of it as a selling feature of our forest policy."
>
> - E.C. Manning, Chief Forester (1941)

> "Intelligent planning for the future economic and social security of British Columbia must take full cognizance of the fact that all the varied uses of her vast forest areas must be correlated and developed to the greatest extent possible. It is not sufficient to think of these forest areas merely of their capacity to produce timber for the wood-using industries, but the relationship between forest cover, fish and game, and the tourist industry must be recognized. Forest management must consider the sportsman and the tourist as legitimate users of our forest areas and sources of revenue capable of great expansion. Certain areas undoubtedly possess greater value for these recreational uses than the cutting timber and must be developed accordingly."
>
> - B.C. Forest Branch Report, 1937

In spite of these worthy and noble statements of vision, little was attempted to develop integrated resource management policies, plans or programs during this early period.

With the modest levels of resource use that existed during this era along with the perceived concept of super-abundance of all resources, perhaps it is understandable (even in hindsight) that the emphasis in British Columbia would be on the expansion of resource use opportunities rather than on integrated resource management initiatives. Or was the reason for inaction more one of influence as contended in a recent thesis by a University of Victoria author when he wrote:

> "Using the administrative and quasi-governmental structures established by conservationists and progressive-minded politicians and foresters, lumbermen succeeded in over-coming most political and bureaucratic resistance to their demands by invoking the shibboleths of investment, development and prosperity for all."
>
> Stephen Gray, 1989

Whatever the reason, this era noble vision, but with little action, leads me to the second phase of my presentation.

THE BASELINE YEARS - (BUT STILL NO ACTION)

I've called these the Baseline Years since I'd like to look at my personal experiences during this period. In spite of what Jim Walker [Director, British Columbia Wildlife Branch] might say, it wasn't that long ago. However, I believe it is important to place this period between the latter 1940's and latter 1960's into perspective if for no other reason than to address the "bemoanings" of the hand-wringing and scapegoat seeking prophets of doom who constantly lament on the deficiencies of the past rather than concentrate on the opportunities of today and tomorrow.

Let's now take my personal look at this era:

> While attending UBC, the phrase multiple use, integrated use, co-use, or whatever was not even mentioned, far less discussed.
>
> Similarly, no course offered information on other resource uses including wildlife habitat requirements. (Before my wildlife biologist buddies relax in their seats with any false degree of smugness, I suspect that wildlife biologists received no information on forest harvesting or silviculture during their time in the hallowed halls of learning during this period.)
>
> Until the mid-1960's, and in spite of being actively involved in forestry programs, I had never met a wildlife biologist far less heard of the habitat needs for moose, elk, caribou black-tailed deer or grizzly bear. (During that era, while in Prince George, I did notice one long-haired, bearded person often wearing one shoe. I never did find out whether he was a wildlife biologist who had lost a shoe or a hippie from Alberta who had just found one.)
>
> Until the mid-1960's, I had neither heard of, nor met members representing any B.C. based environmental group. The one exception was the B.C. Wildlife Federation although even that body's emphasis on broader land/resource use matters was largely still in the future.

I could go on with other examples. But what I'm attempting to emphasize is that whether the reasons were the lack of information, public dis-interest, government inertia, the perceived super-abundance philosophy, or whatever, there was little activity of any consequence in integrated resource management during that period between the latter 1940's and the latter 1960's - my 'Baseline Years". Blame can be placed at the feet of any resource sector should one wish to participate in the "Great British Columbia Game of Scapegoatism". Again, just maybe, the time wasn't ripe for action. If this was so, the time ceertainly became ripe toward the end of the 1960's as a growing number of land/resource use controversies began to erupt throughout parts of the Province. The need for at least rudimentary integrated resource use planning became increasingly evident.

THE DEVELOPMENT YEARS - (THE STIRRINGS OF ACTION)

By the latter 1960's, public resource managers began to recognize the need for integrated resource management plans and programs and such initiatives began in a number of regions of the Province. It is interesting to note that none of these initiatives evolved through new policies being developed, enunciated or implemented from a province-wide perspective. Rather, progress developed as a result of field initiatives by a <u>very few</u> visionary people - almost always members of the then Fish

and Wildlife Branch and the B.C. Foest Service. Not surprisingly, therefore, it was the forestry/wildlife or forestry/wildlife/range interactions that were addressed initially. The success of these regional initiatives can be attributed to these few visionary people who pushed their levels of responsibility to the brink. Regional presentations to policticians, Legislative Select Standing Committees and Commissions meant that, faced with an almost neutral Headquarters' philosophy on the topic, one felt the presence of the end of the limb while constantly awaiting the sound of the saw.

In all hindsight, however, I must admit that the leadership provided through these local initiatives, as opposed to instructions from above, assured the success of these early programs. Certainly, that route was preferable to the time-worn excuse of some: "We're waiting for direction".

I should briefly mention two examples of these regional initiatives:

(a) The Folio Planning Process

This initiative began in the Prince George area toward the end of the 1960's. It's goal was to develop forest harvesting plans that incorporated productivity values and habitat information for other resource uses. Partly because of the nature of the Prince George area and partly due to the fact that the leading proponents of the process represented forestry and wildlife interests, the earlier folio plans had a forestry/wildlife emphasis. The first such plan completed was referred to as the "E.M. & K Plan" in the Salmon River area. Jim Bullen [Forest Service] and Ken Sumanik [Fish and Wildlife Branch] were the pioneers along with the company representative Don Frood [Rustad Bros. Ltd.].

(b) The Co-ordinated Resource Management Planning Process (C.R.M.P)

Following considerable liaison with resource managers and users "south of the line", the mid 1970's saw the C.R.M.P. process being introduced into the East Kootenays. Since many of the resource use conflicts in the region seemed to involve wildlife and cattle use, many of the early C.R.M.P. plans had a wildlife/range emphasis. Just as the Folio process was labelled a forestry/wildlife process, the C.R.M.P. process was often tagged with with a range/wildlife label. Both statements were, and are, incorrect. Both processes were capable of addressing all resource values in an area and each was 100% compatible with the other. I have always found it unfortunate that some continued to refer to the two processes as an "either/or" situation rather than viewing each as building blocks that should lead to improved integrated management plans and programs.

From the East Kootenays, the C.R.M.P process expanded to adjacent parts of the Province - primarily in the southern Interior. I view both programs as a success in operational planning initiatives although, for reason too numerous to mention here, neither reached their full potential in B.C.

You might ask did these initiatives eliminate the conflicts between resource users? The answer is No! It did not and it has not. Why not?

Perhaps the words of an anonymous and infamous wildlife biologist friend of mine form the East Kootenays best identifies one of the major deficiencies in British Columbia's integrated resource management programs. Writing about the C.R.M.P process, he said:

> "The benefits which accrued from the C.R.M.P. process were numerous and not easily measured". As yields in forage, wood fibre and wildlife began to improve along with new grazing, logging and big game hunting opportunities, demands for these resources once again began to increase."
>
> "The Tragedy of the commons" began to repeat itself as the various resource factions began to lobby for an increased share of an improved and expanded resource pie."

My wildlife biologist friend goes on to develop the thesis that in spite of the development of successful operational integrated management plans, they founder on the shoals of a policy vacuum in the Provincial sense. As early as the mid-1970's, Commissioner Pearse, in his final report, stressed the need for a land/resource use strategy for the Province. Further, he stated that it had to be an all-inclusive Government initiative with due public in-put. He specifically stated that such a strategy should not be developed by any one specific agency.

In my opinion, the lack of such a Provincial land/resource use strategy remains one of the greatest deficiencies in realizing the potential of integrated resource management programs. An operational planning process that recognizes site productivity, resource data, local demand and the like that is guided and supported by a Provincial strategy that identifies approved and compatible Provincial and Regional resource use goals and targets must surely be the way to go.

Throughout the past 15 or so years, well-meaning people have made numerous attempts to address this deficiency. Regretfully, all such initiatives have run aground on the "shoals of politics". Some three or so years ago, it was announced that such a Provincial land/resource use strategy was being addressed and developed in the Premier's office itself. Having heard little or nothing in the interim, I can only assume that another attempt has foundered. The newly formed Forest Commission or the Provincial Round Table process may provide the atmosphere for the development of such a plan. Since the total demands on the land far exceed its capability to produce, the development and approval of any Provincial strategy must necessarily enunciate the "bad news"as well as the good. Much as many might wish it could be, the facts are that it can't be Hot and Cold, Wet and Dry, Soft and Hard - all at the same time. For this reason, I am less than optimistic that a meaningful and realistic land/resource use strategy that will specifically identify compatible Provincial and Regional resource use targets will be approved in the near future. I hope that I will be proven wrong.

THE CURRENT YEARS - (THE DILEMMA)

This brings me to the final phase in my integrated resource management historical tale - The Current Era. While I'm normally only too pleased to leave the challenges of tomorrow to the "Young Turks of the Day" such as Ray Demarchi [B.C. Wildlife Branch], John Cuthbert [Ministry of Forests] and Jim Walker [B.C. Wildlife Branch] (and even Whitey Anderson - although with considerable reservation), I would like to conclude with a few comments on today's situation.

If I can be direct for a change, I do not believe that the prime conflicts of the day, or the public concerns of the day, have anything to do with integrated resource management planning and programs. No longer are the issues about size,shape or location of cutblocks in order to protect or enhance other resource values. Thus, the public debate no longer is involved with how or when to harvest timber. Rather, the issue is now whether the area should be subjected to logging at all - clearly a land allocation issue. Resource managers can address the integrated use challenges with some hope of success. On the other hand, the land allocation debate is assuredly in the domain of the politician. As a result, the public resource manager has little hope for success unless the broader land allocation issue is addressed and resolved. Just perhaps, the political level will now begin to appreciate the need for a Provincial land/resource use strategy embracing integrated and compatible resource/land use targets as essential. And just maybe, we may begin to bury the all-too-common perception amongst politicians, resource users and environmentalists that we can keep logging trees, hunting moose, fishing salmon, grazing cattle and preserving old growth with few restrictive measures or negative impacts if only the public servants would communicate with each other.

In conclusion, I'd like to read part of the preface to the publication "The Forest Resource of B.C. - 1937". I believe that the writer, F.D. Mulholland, tends to put into perspective the process of resource use that has occurred, and is occurring, in every resource-based region of the world - albeit not necessarily in the same time frame.

> "Stages in Development - The development of commercial forestry in other countries fortunate enough to possess extensive virgin forests has blazed a fairly definite path for newer countries to follow, profiting by the success of some and the failure of others in their progress towards permanent forestry.
>
> The first stage is exploitation of the surplus growth of centuries, generally destructive, because land must be cleared for farms and towns coincident with the development of an infant industry in what appears to be an inexhaustible supply, and wasteful because production for distant markets must be cheap.
>
> Next come protection, as market developments make forest products more valuable and it becomes evident that the resources of virgin timber have a limit.

> Then it found that protection of the merchantable timber will not, by itself, either ensure the success of natural reforestation or maintain regular supplies of raw material for the large forest industries which by this time have been established. So the exploitation of visible supplies without regard for the future, involving "devastation" is gradually changed to a policy of forest-management for permananet production or "sustained yield". By this polciy the forests are managed according to plans designed to secure reforestation, regulate the cut, provide sustained annual yields, and stabilize forest industries.
>
> Later, when increasing demand indicates that more than the natural growth can profitably be utilized, silviculture may be further developed in order to improve the quality or species of timber grown or to increase the rate of growth and yield per acre.
>
> Finally, when the importance to the community of commercial forestry in relation to other industries, as well as to watershed-protection, recreation, and other forest uses, has become established, all these branches -- utilization, protection, regulation, and silviculture -- take their proper places in the administration of permanent forest areas under policies based upon the economic and social interests of the public."
>
> F.D. Mulholland - "The Forest Resources of B.C. - 1937"

I do not believe that Mr. Mulholland could have envisioned the land/resource use conflicts of today when he somewhat naively refers to "policies based upon the economic and social interests of the public".

Who can dispute that statement? Yet, the current land allocation debate has raised conflicts in resource use to an historic high in this Province.

In this atmosphere, the first victims are the bridge builders; those with a balanced perspective; the listeners; the sensitive people; those that have difficulty handling and dishing out abuse. On the other hand, the survivors in this atmosphere are the cynics, the thick-skinned, the inflexible and those that can take abuse, and dish it out with a dividend. Throughout the Province, and in all sectors, it is the latter group that seems firmly in control today. Yet these individuals who handle themselves so well in the current trench warfare atmosphere have the worst possible traits for those that must seek consensus, compromise and goodwill in integrated resource management initiatives. Where are these people in the ranks of the Industry, Government and Environmental sectors when we need them? They are scattered throughout the Province, more often than not, dead, wounded or, at least, bleeding. When you pull the arrow out of his/her back, don't be too surprised if you find that it just might be labelled with trademark of his/her own sector.

MINISTRY OF FORESTS PLANNING PROCESS PRESENT AND FUTURE

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ABSTRACT

The Ministry of Forests is mandated to carry out integrated resource planning and implements this mandate through a planning framework of five hierarchical and linked processes. Current trends and changes include an increasing emphasis on provincial and regional plans, incorporation of geographic resolution into an analysis framework for all resources and a re-designed planning team which includes all stakeholders. Issues and challenges still ahead are the establishment of integrated resource goals, clarification of the land management mandate between agencies, inclusion of other resource agencies in decision-making, meaningful public participation and the collection of information on all resources. Integrated resource planning requires cooperation, innovation, risk and trust.

THE PRESENT PLANNING PROCESS

The Ministry of Forests is mandated to carry out integrated resource planning by Section 4(c) of the Ministry of Forests Act which requires that the forest service:

> "plan the use of the forest and range resources of the Crown, so that the production of timber and forage, the harvesting of timber, the grazing of livestock and the realization of fisheries, wildlife, water, outdoor recreation and other natural resource values are coordinated and integrated, in consultation and cooperation with other ministries and agencies of the Crown and with the private sector".

This mandate is implemented through an integrated resource planning framework consisting of five hierarchical and linked processes including provincial, regional, forest management unit, local resource use and resource development plans. Provincial and regional processes set broad goals and directions while forest management unit plans determine production goals and management strategies for Tree Farm Licences and Timber Supply Areas. These plans are primarily strategic in focus and are not site specific. Local Resource Use plans are carried out in areas where timber harvesting is anticipated and where there are other significant resource values which require more detailed planning. Resource Development Plans are timber harvesting operation plans identifying road design, cut block lay-out and reforestation prescriptions. These plans are tactical or operational, site specific and only carried out for areas where timber development is planned.

Forestry and wildlife goals are integrated at all levels in this planning hierarchy

although most significantly in local resource use and resource development planning. Mechanisms for integration include participation on planning committees, inter-agency review of plans, referral of timber development plans and cutting permits, inter-agency agreements and development of guidelines.

CURRENT TRENDS AND CHANGES

Planning in the Ministry of Forests is evolving. It has moved from timber extraction to forest management and today to integrated resource management. There have been, and continue to be, significant changes and adjustments to the present planning process, many driven by the goal to develop plans which incorporate all resource values.

Increasing Emphasis on Provincial and Regional Plans

It is difficult to integrate resource goals from the "bottom up" at the local level without strategic direction. There is a growing recognition of the need for more regional and provincial plans. Evidence includes the recent proposal to develop a strategy for old growth on the coast. Regional plans ensure that local issues are examined in a broader context and will result in improved decision-making and fewer local conflicts.

Geographic Resolution and Resource Emphasis Area Concept

Provincial, regional and forest unit level plans are not area-based and as a result make it difficult for other resources such as wildlife which are area-based to be integrated into strategic timber plans. Resource Emphasis Areas (REAs) are a form of land designation which defines, at a strategic scale, areas that have similar features and management potential. They will be used to identify resource issues and possible conflicts, to define areas requiring similar prescriptions or areas needing special consideration and finally, to communicate proposals, options and decisions. Their notation is three tiered identifying major use, secondary use and other important uses. Categories of use include timber, wildlife, recreation and water. REAs will be used in TSA Resource Management Planning. For areas where wildlife is the major emphasis, such as caribou habitat, the use will be identified and designated as such. This land designation will provide guidance to operational level plans, ensuring other resource values are considered and strategic resource goals achieved.

Analysis Framework Which Integrates All Resources

It is difficult to choose one integrated management option versus another without first assessing and quantifying the impacts of each. Current analysis models are primarily concerned with projecting timber supply and provide limited ability to incorporate other resource concerns. The Analysis Framework of Integrated Resource

Management (AFIRM), proposes a framework which incorporates all resource analyses equally. This will provide the information required to assess integrated management options by quantifying the impacts on each resource in a comparable manner.

New Planning Team Structure

A new planning team structure has been approved by the Ministry of Forests which provides for equal participation of all stakeholders in TSA Resource Management Planning. The team has three tiers. The core is made up of government professionals from the relevant resource ministries including forestry and environment and will direct and coordinate preparation of the Resource Management Plan. The second tier, sectoral sub-committees made up of resource licensees including timber and guide/outfitters, will investigate and develop sectoral issues and recommend proposed courses of action of the core committee. And finally, associations and interest groups will assist the process by identifying issues to sub-committees and reviewing draft documents. This new structure will be prototyped in several TSAs in 1990 and will provide a mechanism for wildlife planners to be equal partners.

THE ISSUES AND CHALLENGES AHEAD

Although many changes are already in place and have gone a long way to achieve integrated resource management, there are still several challenges facing resource managers.

Establish Integrated Goals for all Resources

Other agencies either do not have resource goals or, if they do, it is not clear that they have been approved or integrated with other resource goals. It is very difficult to incorporate goals which do not exist or are set locally and may represent a "wish list". The Forest Service reacts to other agencies requests, usually at the operational level, with very little insight as to the impact on other resource goals or the cost and value of implementing their request.

Other Agencies Participate in Decision-making

Other agencies do not have decision-making authority in Forest Service planning processes. Since they have no role in making decisions, other agencies may be alienated and have the view that the predominant emphasis is on Forest Service goals. This may prevent acceptance of the decision and will lead to the continuation of each resource agency developing their own plans which may or may not conflict with Forest Service plans, spawning ongoing conflict.

Clarify Land Management Mandate

Even if other agencies fully participate on planning teams and are included in decision-making, they may not accept the primary principle that the Forest Service is the lead agency for land management planning. Although the Section 4(c) of the Ministry of Forest Act appears to give the Forest Service the strongest mandate, the legislation is not definitive and other agencies may not buy-in.

Recognition of the Public as a Participant

The first requirement for improved public involvement is a recognition that it is required and secondly, a commitment to follow through. Hand in hand with this is a recognition that public involvement is not just communication but that it is also participation in a meaningful way. A significant change in philosophy is required by resource managers to include the public and give due recognition to their values. The next challenge will be in developing a mechanism to include the public.

Resource Information Requirements

In order to analyze all resources as proposed in AFIRM, inventories and models are required for all resources. A great deal of information exists for timber but very little for other resources such as wildlife and thus making resource analysis very difficult. Wildlife inventories and models are required and must be coordinated with timber inventories and models.

CONCLUSION

There have been significant strides in integrated resource management, but there is still a long way to go. Implementation of a truly integrated resource planning process requires cooperation, innovation, risk and trust. Plans can no longer be developed individually nor can each resource sector or stakeholder achieve 100% of their goals. Our natural resources are not infinite. We all must give up something, and if we don't, we will all lose.

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MINISTRY OF ENVIRONMENT WILDLIFE AND FISHERIES PLANNING PROCESS: PRESENT AND FUTURE

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ABSTRACT

Unlike the Ministry of Forests, the Ministry of Environment has no mandate to plan. In the absence of legislative direction, the Ministry is attempting to create policy within which to develop regional wildlife plans and establish priorities for land, forest, and water management initiatives that can be used in an integrated resource management process. These initiatives are limited by a comparatively poor inventory of most wildlife species, relatively little documentation of the impact of various forest management activities on wildlife habitats, and a budget that is not adequate to gather this information.

To address emerging public expectations regarding wildlife and timber management, not only must the deficiencies noted above be redressed, but an integrated resource planning and management process developed in which the Ministry of Environment is an equal partner, and which provides for greater public involvement.

WHAT IS THE PRESENT PLANNING PROCESS?

MINISTRY PLANNING

Unlike the Ministry of Forests, the Ministry of Environment is not mandated to carry out integrated resource management planning or, for that matter, any other kind of planning. This also applies to the individual programs within the Ministry such as the Wildlife Program, the Fisheries Program and Water Management Branch.

There has been a lack of direction at the corporate level and because of it, all past planning initiatives have lacked focus and have not been coordinated. As an example the province was divided into approximately 30 strategic planning areas and considerable effort was put into plan development. Only a few plans were completed before the initiative was suspended as the product had questionable usefulness. One of the completed strategic plans was the Finlay-Omineca which takes in the Williston Lake drainage area. Also, as a consequence of the lack of focus, planning at both the strategic and operational levels done by the individual Ministry programs varied considerably. Most planning was done to address specific issues, but this is changing.

To give focus to Ministry planning, the Ministry is in the process of developing a Ministry Strategy. The following Mission Statement is under review:

> "To encourage a sustainable environment, curb environmental degradation, and ensure that environmental management can meet the changing needs and priorities of the many users of our resources"

The Ministry is also establishing Guiding Principles and, for the next five years, Strategic Priorities. The proposed Strategic Priorities include the following for Environmental Management:

1. "To promote economic and recreational opportunities and ecological diversity by improving the management and allocation of water, fish and wildlife, and ecological resources;

2. Improve the Ministry's response to requests from other agencies and the private sector for environmental input to logging, agricultural, mining and other development projects, by improving inventory and increasing on-site operational capability."

These strategies provide the basis for Ministry programs to participate in land use planning and resource development.

WILDLIFE PROGRAM PLANNING

As this is a Wildlife/Forestry symposium I will elaborate further on planning processes within the Wildlife Program. It should not be forgotten, however, that there is significant involvement by other Ministry programs like Fisheries and Water Management into Ministry of Forests and forest industry initiatives.

Within the Wildlife Program two planning processes have been under way for several years. These are the development of Regional Wildlife Management Plans and, secondly, Species Management Statements. The Regional Wildlife plans were conceived as internal working documents developed to establish priorities for dispersal of effort and budgets for wildlife management activities. In the last decade the plans have been upgraded with the addition of a habitat protection component. A combined list of regional management and habitat protection activity priorities has been developed. Near the top of the list is participation in Timber Supply Area (TSA) and Tree Farm licence (TFL) plans, forestry operational plans and access management planning due to the tremendous impact forestry has on wildlife. These regional wildlife management plans, however, do not contain the detail required for integration into the Forest Service planning initiatives.

The Species Management Statements were developed (and are currently being upgraded) for individual wildlife species or groups of species and are provincial in scope. They identify goals and objectives for the management and protection of habitat of individual wildlife species or group of species. These documents will be available to the public.

A major weakness in the Wildlife Program has been the lack of a program strategy. The Program is presently working on a Provincial Wildlife Strategy and action plan which should be completed this spring. A Mission Statement has been adopted along with five Goals.

The Mission Statement is:

> "To Manage the province's wildlife resources for the benefit and enjoyment of British Columbians, by maintaining an optimal balance between ecological, cultural, economic and recreational needs."

The overriding program Goal is "to maintain and enhance wildlife and their habitats, and thus ensure an abundant, diverse and self-sustaining wildlife resource throughout British Columbia". The Provincial Wildlife Strategy will soon be made available to the public and other government agencies for review.

The Provincial Wildlife Strategy will be the umbrella document for the Regional Wildlife Plans and Species Statements previously referred to, and also a Land Management Strategy (Figure 1). The Land Management Strategy will guide land management activities for wildlife, for example providing priorities for acquisition of private land, obtaining control of Crown land, wilderness area proposals and influencing land and water use decisions. The Land Management Strategy is currently under development.

Many sub-regional and operational plans for smaller areas have been prepared as needed. They usually address wildlife supply/use problems or problems where there is significant interaction between wildlife/environment and outside agency plans.

WHAT DO WE DO NOW AT THE VARIOUS FOREST MANAGEMENT PLANNING LEVELS?

Since management of the Crown forest land base rests with the Ministry of Forests and as most wildlife is dependent on the forests and forest lands for all or part of their existence and well-being, the management of the forests is of extreme concern and importance to the Wildlife Program. Section 4(c) of the Ministry of Forests Act requires the Forest Service to coordinate and integrate fisheries, wildlife, water, outdoor recreation and other resource values with production of timber. To this end the Forest Service invites comment on their plans through inter-agency planning processes, especially the inter-agency referral system.

The Wildlife Branch is asked by the Forest Service for input into Resource Management plans (RMPs) for TSAs (Timber Supply Areas) and TFLs (Tree Farm Licence areas), LRUPs (Local Resource Use Plans), operational plans and individual cutting permits. The most important of these plans are the RMPs for TFLs and TSAs as it is at this relatively broad planning level where deductions in the allowable annual cut of timber from the forest timber base occur for other resources, including wildlife, or for operational reasons. It is where the allowable cut is determined and it is also where the conditions for timber harvesting and integration of other resources, like wildlife, are set. The process for input by the Wildlife Branch is not perfect but it is evolving and is certainly much better than it was a decade ago.

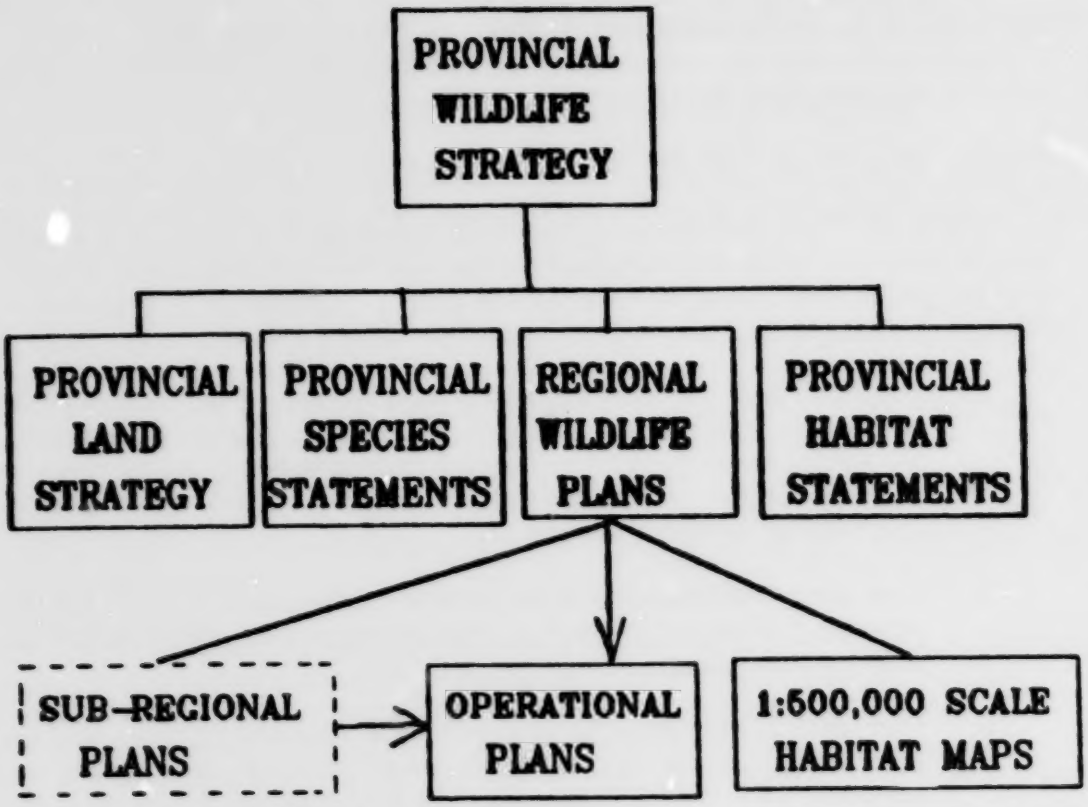
PROVINCIAL WILDLIFE STRATEGY
PROVINCIAL LAND STRATEGY
PROVINCIAL SPECIES STATEMENTS
REGIONAL WILDLIFE PLANS
PROVINCIAL HABITAT STATEMENTS
SUB-REGIONAL PLANS
OPERATIONAL PLANS
1:500,000 SCALE HABITAT MAPS

Figure 1

Participation in LRUPs has expanded immensely in the past two years and it is expected to continue to grow. These plans, usually for small areas where a variety of conflicting land and resources uses occur, come closest to being truly integrated resource use plans. However, much depends on the attitude of the District Forest Manager.

At the operational level we are interested in minimizing the impacts of specific harvesting plans, access development proposals and silvicultural plans. This is accomplished through recommendations on cutblock size and distribution, scheduling, weighing road and silviculture alternatives, etc.

WHAT CHALLENGES ARE AHEAD FOR WILDLIFE MANAGERS?

There are major challenges facing wildlife managers that hinder their ability to respond to the demands of integrated resource management and to providing the input needed to meet public, client and other agency expectations in integrated resource management. They must be overcome. These include:

1. Relatively poor inventory for most wildlife species. Even for high profile species like moose there is only an approximate estimate of numbers. Related to inventory is an inadequate understanding of the biological needs of many species, of their dependence on forest habitats and of inter-relationships between species.

2. Lack of an understanding of the impacts of the various forest management activities (harvesting, protection, silviculture) on most wildlife species and their habitats, especially over the long term.

3. Compared to the Forest Service, very small amounts of money and low numbers of staff are allocated to integrated resource management. There are about 14 Full Time Equivatents (14 person years) committed in all of BC to forest planning and forestry referrals. A significant portion of these 14 is concerned with protection of fisheries habitat. The current workload cannot be met and there is little hope of responding to any new initiatives.

4. Wildlife goals and objectives not defined to provide usable products, products that can be use in integrated resource planning. To meld into Forest Service and (Lands Branch) planning scenarios, wildlife inventory and requirements need to be defined in units that can be incorporated into forest management planning.

5. In many cases wildlife goals and objectives are not clear. Are we attempting to ensure the survival of a species in the light of forest management activities, to provide viewing opportunities, or are we wishing to have harvestable surpluses? If harvestable surpluses are the objective,

then how large and where should they be?

6. There is no legislation which can be used to protect most wildlife habitat on Crown land. It is not always possible to provide adequate protection for wildlife through a review of forest development and other kinds of resource development plans. There is no legislation permitting control of human activities, other than hunting, that may impact on the ability of wildlife to use habitat, particularly critical habitat.

WHAT ISSUES ARE FACING INTEGRATED RESOURCE MANAGERS?

Resource managers, especially forestry and wildlife managers, must contend with several overriding issues that have significant impacts on integrated resource use planning, or will have in the future. They include:

1. The expectations of the public regarding wildlife management and forest management are changing and changing relatively rapidly. Traditional wildlife and forest management is being challenged and both are in varying states of turmoil. The public has come to realize our natural resources are finite. There is growing realization that compromises are required. No resource can expect to produce at its maximum if other resource values are to be considered. Management of all our resources, not just wildlife and timber must be responsive to these changing values, perceptions and expectations.

2. The current models used to assess timber supply and make decisions have very limited capability for incorporating other resource values including wildlife. Forest management planning is largely directed to timber management and production. The Analysis Framework of Integrated Resource Management (AFIRM) proposes a framework which incorporates all resource analyses as equal participants in a co-ordinated way. But this is likely several years away and likely will be encumbered by the deficiencies in wildlife inventory, and georeferencing this inventory, far into the future.

3. The lack of common planning units is a major barrier to integrated resource management planning. Common planning units need to be defined so that the different resource values can be compared, options weighed and trade-offs made. One possibility is ecological land units. The distribution and abundance of wildlife, forests and water are all related to climate, soils and topography. Biogeoclimatic mapping has now been done for all of British Columbia but has not formed the basis for Regional Forest Resource Management Plans or Regional Wildlife Plans. However, biogeoclimatic units are being used at operational level forest plans and wildlife plans.

4. A major issue that has come to the forefront in the past decade and must be addressed in forest management is that of biodiversity. Managing forests for timber production alone has the potential for causing immense changes in nature's variety, the number and frequency of ecosystems, species and genetic pools, that is, the biodiversity which naturally exists. The implications for man, his environment, or indeed for all life forms are enormous. But at what scale should the maintenance of the great natural variety of ecosystems and life be managed? Should it be by first or second order watershed, by ecological land unit, by planning cell, or some much larger land unit? There is probably is no simple answer.

5. Public involvement is required at all levels of planning. The challenge will be to determine how to get the public involved and keep the public involved. Current levels of involvement are unsatisfactory especially to the affected public. There will have to be innovative solutions found. The public is donating their recreational or free time, unlike public servants and industrial interests.

6. Final decisions regarding management of forests rests with the Ministry of Forests. There is need for a level playing table where all players, including the public, have an equal vote and all resource values can be considered equally, priorized, and decisions made on their use and allocation. When there are conflicting resource values, the Forest Service is constrained by licenced cut commitments even when they know decisions are not in the best interests of wildlife or other resource values. It is only through better planning and more local input that resource use conflicts can be minimized.

In closing, in the future the Ministry of Environment expects to become even more involved in provincial, regional and local resource and land use planning. The Ministry expects greater public involvement in decision making; it also expects to have a more equal position in decisions affecting the forest land base.

BIODIVERSITY: WHAT, WHERE, WHY, AND HOW

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ABSTRACT

Subspecies are convenient units for assessing biodiversity because they are recognizable and represent real genetic diversity. Species are less controversial, and at the species level Canada contains high diversity for a north temperate nation. Larger species (>1 kg) are better represented in Canada than elsewhere and most of the wildlife are forest-dwelling (60% of the breeding birds and 76% of the terrestrial mammals). Many of the species use cavities in trees to breed (52 birds and 28 mammals) and a large portion require mature or old-growth forests. Because of its diverse topography and vegetation, British Columbia contains the richest wildlife diversity in Canada, 70 and 72% of the nation's native breeding birds and terrestrial mammals, respectively. Eight major reasons for maintaining wildlife diversity are reviewed, as are the three approaches that will permit maintenance of wildlife diversity in forested ecosystems: 1) integrated management in individual stands, 2) allocation of silvicultural and harvesting practices through time and space, and 3) preserving areas free of forestry practices. Integrated forestry-wildlife management has produced success stories and will help maintain many wildlife species. The theory addressing size and shape of preserves provides guidelines but is not universal and has inherent uncertainties. Impacts on wildlife of the allocation of forestry practices through time and space are poorly understood, but we are defining the problem more clearly.

INTRODUCTION

Only two decades ago North American resource managers could go comfortably about their business with a rather simple and practical definition of wildlife: species which we ate, which we wore, or which ate our crops. The simplicity is gone. Over much of North America the number of species for which managers are accountable has increased about ten times in two decades. One reason for the expansion of this definition of wildlife is discomfiting to managers. The expansion results from public concern. Different citizen groups champion different species or groups of species; somehow all species must be acknowledged or a portion of our pluralistic democracy is angry and active. Managers now have little choice but to embrace biodiversity whether it be from ethical concern, practical survival, or simple desperation.

In this paper I examine the definition of biodiversity, where diversity is concentrated, the arguments for retaining diversity, and ways to retain diversity in forested ecosystems. Lorraine Andrusiak, Laurie Kremsater, and Peter Opie helped tally wildlife species present in specific areas. Reviews by Jacklyn Flett Johnson and Laurie Kremsater improved the manuscript.

WHAT IS BIODIVERSITY?

We can define diversity, as long as we do it quickly without thinking deeply. Webster says "the state of being diverse; difference; dissimilitude; variety; distinctness or separateness of being, as opposed to identity". We falter in our definition only if we pause to ask "what is the nature of the difference?" We know that all vertebrate species possess differences when viewed at one level - the genotype (see review of Bunnell 1978). Nature confronts man-made definitions by providing no unambiguous level for determining difference. The difficulty in deciding how different something must be before we consider it a separate entity that has increased diversity is no mere semantic problem nor meagre sophistry. It is troublesome.

Bunnell and Williams (1980a) described these troubles this way:

> The troubles surround us disguised in jargon terms. For about two decades it was fashionable for ecologists, economists, and sociologists to ponder H', H_{max}, and other diversity indices. . . They each treat some aspect of diversity. Art historians and scholars discuss harmony, balance, and composition--other dimensions of diversity. Medical physicists estimate the minimum amount of diversity necessary for computers to recognize different blood cells or for artificial eyes to see--they call it pattern recognition. Electrical engineers, cyberneticians, and some criminologists acknowledge the "law of requisite variety" and attempt to estimate how much diversity must be in a controlling system before it can effectively control. While specialists debate diversity in specialized terms each of us recognizes diversity's importance in such aphorisms as "variety is the spice of life" or "a change is a good as a rest".

The theorists have no universal definition. We need no definition to appreciate diversity in diet, music, or art, and to capture its value in aphorisms. We do need some definitions when communicating distinctions or when formulating management goals, policy, or laws. Bunnell and Williams (1980a) argued that a useful level of distinction for biodiversity was the subspecies. I still agree with their arguments and basic point: although subspecies are an ill-defined taxonomic unit, they represent real, recognizable genetic diversity. If we commit ourselves to maintaining diversity, subspecies will capture greater variation than will species. Although I believe that subspecies are helpful units for describing diversity, in this paper I have assessed diversity in terms of species. That choice simply reflects the greater agreement we have in designating species as compared to subspecies.

WHERE DOES BIODIVERSITY LIVE?

To illustrate where diversity lives, I have compared Europe and Canada. As defined in Table 1, Europe includes Iceland, European Russia, and the Mediterranean islands and extends from about 36° to 72° N. The selection of these two regions

Table 1. Numbers of native mammals and birds in selected north temperate areas.

Location	Mammals		Birds	
	Species	Families	Species	Families
Europe[a/]	122	24	388	66
France	77	20	221	63
Germany (reunified)	65	18	214	54
Poland	61	18	207	56
Sweden	55	16	240	55
Great Britain	43	14	194	55
Canada	140	24	407	50
British Columbia	102	21	282	42
Vancouver Island	29	11	140	38
Continental U.S.A.	316	24	622	52
Alaska	54	14	94	36

[a/]West of 30° E; including Iceland, Britain, and Mediterranean islands.

permits comparison of two north temperate areas of almost identical size (about 10 million km^2 each). My sources to assess diversity were Banfield (1974), Cook (1984), Corbett and Southern (1977), Cowan and Guiguet (1956), Godfrey (1986), Peterson et al. (1983), van den Brink (1967), and van Zyll de Jong (1983,1985). Only surviving native species were considered. This approach was problematic in only a few cases. I assumed the Barbary ape (Macaca sylvanus) was introduced to the Rock of Gibraltar, but considered that the porcupine (Hystrix cristata) was native to Europe. Some workers suspect that the latter species was introduced to Italy and Sicily by the Romans.

The summary indicates that despite more northern climates than Europe (Canada extends from about 42° to more than 80° N) much of the wildlife diversity lives in Canada. The native European mammal fauna has 13% fewer species than Canada (Table 1) and 28% fewer species greater than 1 kg in weight (Table 2). There are more wildlife species present in the continental United States but we expect that. Although the U.S. is somewhat smaller than Canada it includes areas from about 25° N to 72° N, a north-south distance of about 5300 km. Alaska captures many of the northern species, while southern California, New Mexico, Texas, and Florida contain many subtropical forms that are much more abundant in Mexico and farther south. In short, as a north temperate nation Canada contains a great diversity of wildlife and a unique representation of larger forms.

Within Canada, most of that diversity is present in British Columbia (Figure 1). That province is home to about 70% of the native breeding bird species, 72% of the terrestrial mammal species, 49% of the amphibian species, and 41% of the terrestrial reptile species in Canada. The concentration of wildlife diversity in the Pacific Northwest is a general phenomenon in North America. Washington and Oregon with less than 5% of the land mass of the continental United States are home to about 42% of the native terrestrial mammal species and 37% of the breeding bird species, including the subtropical forms (Bunnell and Kremsater 1990).

The diversity of our fauna is not commonly appreciated. The degree to which that fauna is forest-dwelling is even less well known. A close relation between fauna and forest is expected in north temperate regions, given the extensive forest cover there. Well over half of the mammals in both Europe and Canada are forest-dwelling; in Canada 60% of the diverse bird fauna also is forest-dwelling (Table 2). As expected, areas with more forest cover host a greater percentage of forest-dwelling species. Vancouver Island, for example, which is largely forest-covered, contains a very high percentage of forest-dwelling wildlife (Table 2). The United States with large areas of non-forested habitat hosts many species that do not require forest cover (Table 2, see also Bunnell and Kremsater 1990). A large proportion of both birds and mammals are cavity-dwellers, requiring trees that are older and often containing some rot (Table 2). That observation suggests that many wildlife species will be restricted to older seral stages.

The relations between forest seral stages and breeding requirements of birds and mammals are illustrated for 115 wildlife species on Vancouver Island (Figure 2). The six seral stages illustrated are those generally used to express wildlife relations

Table 2. Attributes of the native bird and mammal faunas of selected north temperate areas.

Location	% Forest-dwelling		% Cavity-using[a/]		Mammals >1 kg	
	Birds	Mammals	Birds	Mammals	N	%
Europe	38	65	29	38	31	25
France	46	69	33	49	17	22
Germany (reunified)	46	71	34	46	16	25
Poland	48	74	34	44	16	26
Sweden	40	80	34	36	18	33
Great Britain	36	70	33	33	10	23
Canada	60	76	20	26	43	31
British Columbia	77	81	20	29	39	38
Vancouver Island	81	93	23	48	12	41
Continental U.S.A.	58	45	18	25	63	20
Alaska	50	72	21	6	28	52

[a/] Percent of forest-dwelling

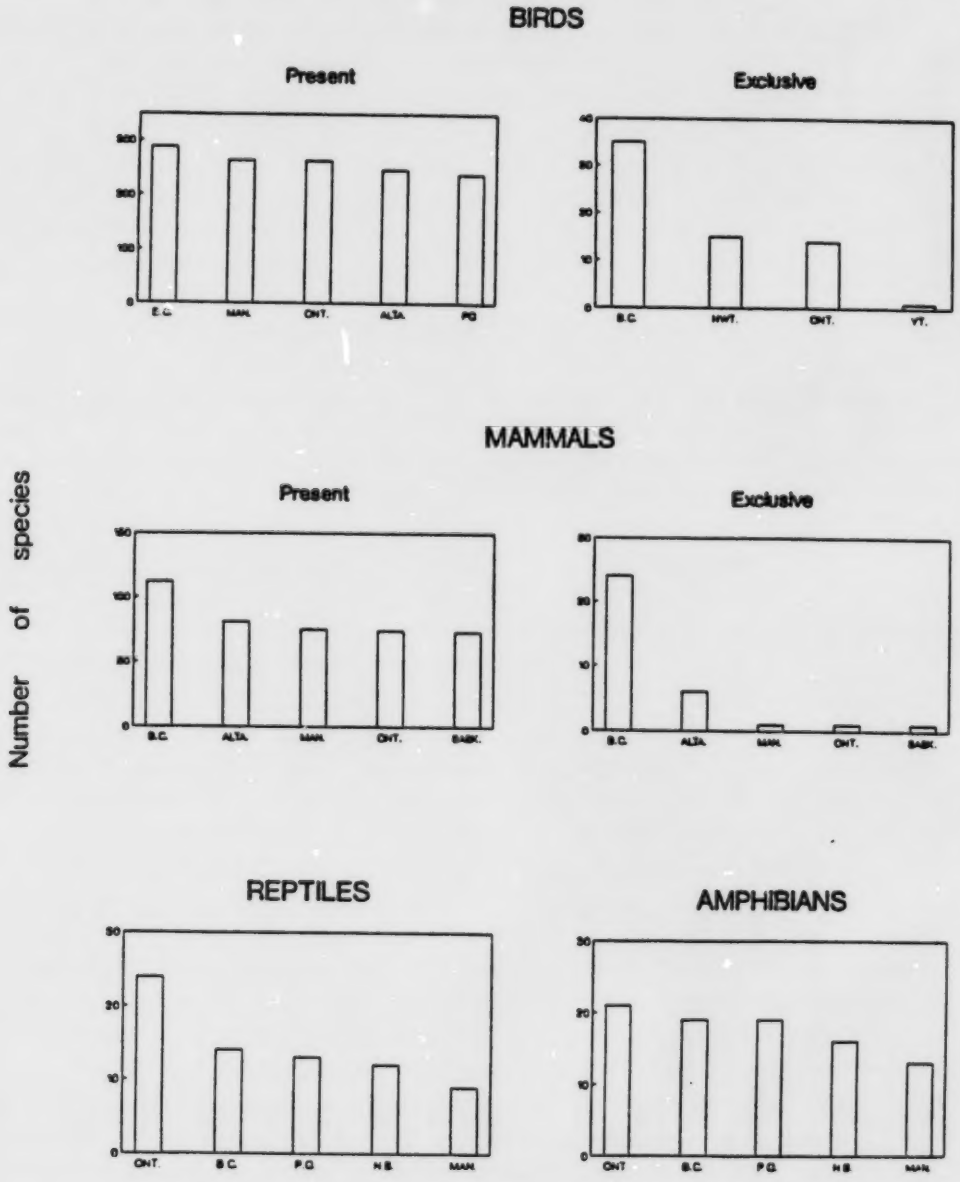

Figure 1. Relative diversity of wildlife in Canada. The five top-ranking Provinces or Territories are shown for each group of terrestrial wildlife (seals, whales, and their relatives are excluded); 'exclusive' means the species is found in only one Province or Territory in Canada. Data for birds and mammals are adapted from Bunnell and Williams (1980a) and include introduced species; the ranking does not change when these are excluded. Data for amphibians and reptiles were extracted from Cook (1984).

with forest succession (Bunnell and Eastman 1976; Thomas 1979; Brown 1985; Bunnell and Kremsater 1990). On the best forest sites in Canada most of the wildlife species present do better in the older seral stages, particularly the mature and old growth forests (Figure 2).

In summary, Canada contains a great diversity of north temperate wildlife and much of this diversity is represented in British Columbia, especially birds and mammals. The majority of these wildlife species are forest-dwelling and many of them require older seral stages in which to breed. Because many of these species are larger, areas of habitat required also are large. The relative proportions of the world's population of different species were not treated explicitly in the summaries, but one point is evident. Canada, especially British Columbia, is one of the few areas where systems of combining several large predators and their prey remain intact.

WHY RETAIN BIODIVERSITY?

I have attempted to summarize briefly all major arguments for retaining diversity. For a more comprehensive review see Bunnell and Williams (1980b) and Ehrenfeld (1976); Ehrlich and Ehrlich (1981) provide a detailed treatment of four of these arguments. A somewhat different classification is offered in the thoughtful summary of Livingston (1981). The arguments have diverse origins, from religion to economics; often they are intertwined and cannot be neatly separated. The major ones are:

1. aesthetic values
2. moral (religious) values
3. economic values
4. future values
5. practical values
6. indicator values
7. value as blueprints
8. we want it

Aesthetic Values

Aesthetic means "to perceive by the senses". Enjoyment of each species perceived is non-consumptive. The species are treated as "works of art" that can instill pleasure or satisfaction (Coimbra-Filho et al. 1975) or as entities that merit preservation by nature of their "intrinsic worth" (Taylor 1981). Critics of the "natural art" argument for diversity explain that it trivializes nature and reduces majesty to amusement, or deride its romantic roots as naive in a world of limited resources and burgeoning population. Critics of the "intrinsic worth" portion of the argument note that Orwell's pigs had it right: some forms of life (us) are clearly more equal than others (say, Salmonella). Although land managers faced with practical decisions may find the argument fatuous, they would do well not to ignore it. The concern for "natural art" has been thoughtfully expressed by several writers (e.g., Carr 1964; Coimbra-Filho et

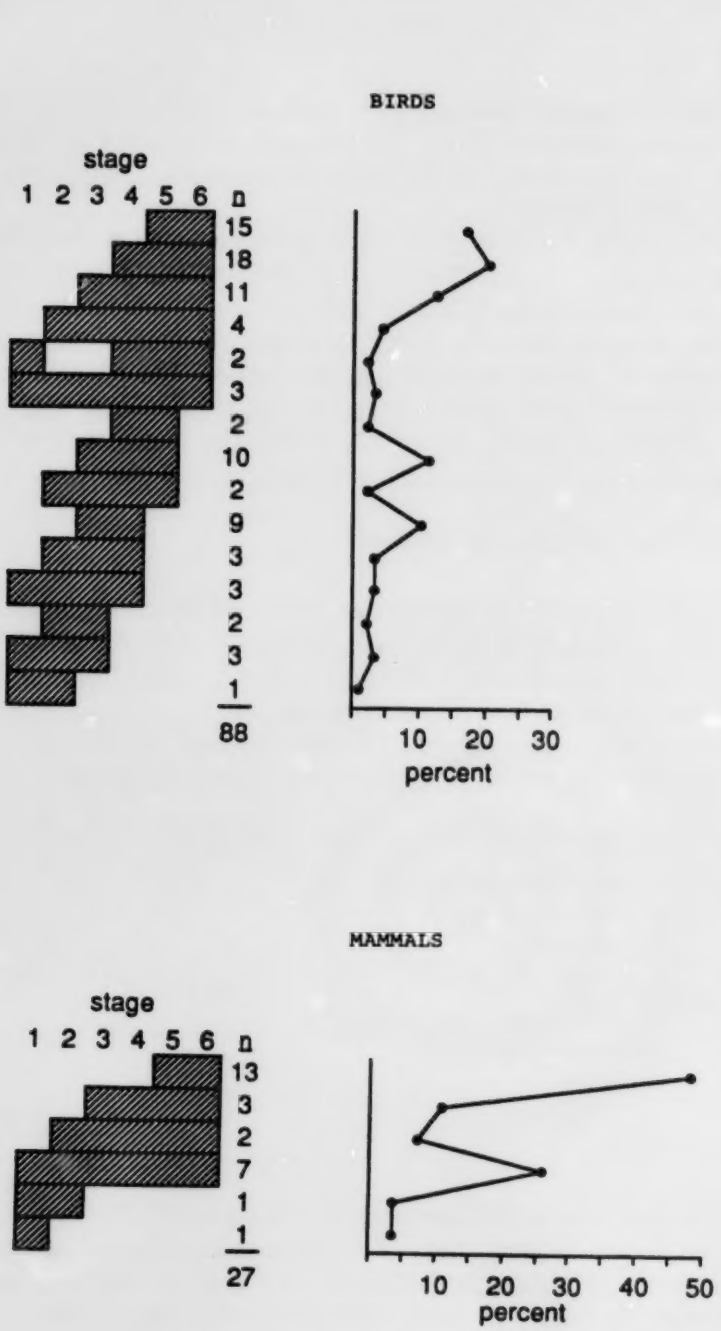

Figure 2. Association between forest seral stages and breeding habitat of forest-dwelling birds and mammals of Vancouver Island, B.C. Birds breeding on lakes or ponds are excluded. Seral stages are: 1 = grass-forb; 2 = shrub-seedling; 3 = pole-sapling; 4 = young forest; 5 = mature forest; 6 = old-growth forest. Data are from Sadoway (1986: App. 13.5) and Sadoway (1988: App. 5).

al. 1975; Ehrenfeld 1976). The argument evokes powerful appeal among those who receive pleasure from nature and appears frequently in the writings of naturalists (e.g., Leopold 1949; Curry-Lindahl 1972; Mosquin and Suchal 1977). For some individuals the argument is sufficient reason for retaining diversity.

Moral (Religious) Values

The aesthetic argument explains that each species is a valued work of art and should be preserved either as a source of satisfaction or simply because it is. What I have grouped under moral arguments takes several forms. Some of these forms explain that man has an obligation to husband all species for his and their mutual benefit. The fundamental reason may be either that elimination of life forms is itself morally wrong, or that we have a moral obligation to future generations to conserve a heritage we hold in trust. For others the argument derives from the notion that every species has intrinsic worth (e.g., Taylor 1981).

For many the argument is simple: it is immoral to take life and "... extermination of whole species is immoral to a materially higher degree." (Munroe 1977). The belief in an obligation to future generations also is derived primarily from specific moral or religious grounds, although one could argue that it reflects concern for our inclusive fitness. It is clear, however, that the ethics of preserving resources are not simply concerns of the religious or idealists. In the United States the extension of these beliefs into law is evident in the case of Dexter vs The State of Washington. A forest property owner would not agree to leave sufficient trees to ensure natural perpetuation of a stand of timber. In his decision for the state, the judge quoted Edmund Burke to note that there exists a great unwritten compact between the dead, the living, and the unborn. He held that "such an unwritten compact requires that we leave to the unborn something more than debts and depleted resources." The case was sustained in the U.S. Supreme Court November 7, 1949 (Bunnell and Williams 1980b).

In North America, the argument is probably best expressed by Aldo Leopold's "The Land Ethic" in A Sand County Almanac (1949). Leopold argued that to conserve resources to improve an economic situation is valuable, but it is not enough; conservation should be considered a moral obligation. The essence of this argument has now been argued globally by the Brundtland Commission's report (Our Common Future, 1987). Given the deep spiritual roots to this argument only a very naive manager would ignore it.

Economic Values

Arguments seeking to illustrate current or future economic utility of species are the most pervasive in the literature. Bunnell and Williams (1980b) observed that this abundance is expected. Species or communities that lack an economic value or demonstrated potential value as natural resources are not easily protected in societies that have a strongly exploitive relation with nature. Consequently, defenders of such "non-resources" often attempt to secure protection by demonstrating a value that will

transform non-resource to resource.

There are two broad schools of thought concerning the economics of non-resources. Some (e.g., Allen 1974) argue that

> . . . the economic climate now and for some time to come is likely to give men every incentive to be gimlet-eyed and stoney-hearted, so that only the most severely practical [economic] arguments will prevail
>
> Faint-hearted ecologists who fear that their favourite species <u>are</u> damned-well useless will just have to risk it. No doubt there is some redundancy in the system, but there are strong theoretical grounds for believing that most of the species on this planet are here for a better reason than that they are poor galactic map-readers.

The other school of thought contends that aesthetic and moral arguments will provide the best or, at least, most honest defence of non-resources or species without demonstrated economic value. This case is convincingly presented by Ehrenfeld (1976) and extended by Bunnell and Williams (1980b) and Livingston (1981).

There are economic values to diversity that are commonly overlooked. Forest birds, for example, provide diligent and free control of some insect pests which would cost us about $1800 US per km^2 per year if we did it ourselves (Takekawa and Garton 1984). Small mammal predators and raptors likewise exert strong influences on small mammal pests in forests. Their impact has never been assigned an economic value. With no economic trickery, the wildlife resource in B.C. generates about one billion dollars annually. Despite these straightforward or more equivocal values, I still believe that economic arguments are only one of many reasons why we should maintain biodiversity. Ehrenfeld (1976) noted nine classes of economic value that are commonly used to transform non-resources to resources. Although those particular economics often use some form of trickery or poorly founded guess, there are many good examples where each argument is valid and important. Simply put, appropriate economic analyses have demonstrated the economic value of species or habitats not normally considered as resources (e.g., Ehrenfeld 1976). The dangers of relying solely on economic arguments still remain. Many of these dangers are reviewed by Bunnell and Williams (1980b); the most important is that species can be exterminated within rational economic policies (e.g., Clark 1973). In short, we often have undervalued resources that we use for free, and careful analysis reveals them to have surprisingly high economic value. Economics, however, captures biological principles poorly and is ill-equipped to deal with all reasons for preserving diversity.

Future Values

Bunnell and Williams (1980b) noted that uncertainty about the future is implicit in many arguments marshalled to preserve species and habitats. An uncertain future is a reason sufficient in itself, provides an unstated reason for assigning economic value,

or contributes to arguments stressing responsibility to the unborn. In its many forms the argument recognizes the potential irreversibility of actions, the desire to maintain as many future options as possible, and the value of diverse genetic resources. It is evident explicitly in the Brundtland Commission's concept of sustainable development, which affirms the retention of resources for future, alternative uses.

Our concerns for nature are as entangled as the webs of nature; the argument for future values does not untangle easily. Here I note potential futures primarily in terms of their biology. It is no great step to relate them to economic or moral values. At the biological level, the argument considers the spectrum of species as an enormous repository of some of mankind's most valuable raw materials (e.g., Meyers 1976). Man's documentation of the potential in this repository has barely begun. Only about 2% of the earth's estimated 200,000 flowering plants have been screened for alkaloids, nonetheless producing about 1000 different forms. Among their uses, these forms have helped us treat tumorous cancers, leukemia, cardiac problems, and hypertension. Myers (1976) noted that ichneumonid wasps have proven useful in biological control of insect pests. There are, however, about 250,000 species, of which less than 1% have been well studied. We find surprises everywhere we look carefully: some insects present in uncultivated fields prove better pollinators of crop species than do honey bees, some bacteria prove effective at detoxifying our pollutants, the cotton-topped marmoset lends itself to the development of an anti-cancer drug, squids and sea hares aid studies of neuroscientists, the armadillo provides insight into control of gestation and miscarriages, jojoba bean oil proves unusually stable at high temperatures. When we consider that we have somewhat more than 98% of earth's species to screen for direct utility to man, it is little wonder that many individuals see enormous future values. The matter becomes even more significant when we consider the narrow genetic base of many of our crops (e.g., Harlan 1975) and our newly gained prowess at borrowing genetic material from nature's diverse pool. Most simply, the message in this argument is: if we can't be good, at least we can be prudent.

Practical Values

Like most arguments for diversity this one may proceed on an ethical-philosophical level or derive purely from practical survival. Usually it is mixed. Philosophically it relates to Leopold's land ethic, and emphasizes that man must recognize his limited knowledge and dependence on the same natural laws as other organisms. Elton (1958) wrote after Leopold and noted that there were three reasons for the conservation of natural diversity: "because it is a right relation between man and living things, because it gives opportunities for richer experience, and because it tends to promote ecological stability -- ecological resilience to invaders and to explosions in native populations." Elton's hoped-for harmony of these three reasons would attain the same end as Leopold's land ethic.

As Bunnell and Williams (1980b) noted, Elton's treatise was scientific. We have tended to avoid his first reason because it was embarrassingly spiritual. For decades

we substituted "hard scientific" proofs of value which often proved inadequate (e.g., Ehrenfeld 1976; Livingston 1981). More recently, frightening evidence (acid rain, holes in the ozone layer, climate change) has demonstrated that when we are persistent enough we can overcome nature's resilience. That evidence plus frustration with traditional planning have led thinking back to Elton's first reason, with one difference: the relation between man and other living things need not be "right" ethically or spiritually but it is "right" for man's continued survival.

Now it is scientists and managers, not naive idealists, who argue that problems can be averted (and money saved) by good design of man-dominated systems or repair of faulty ones, using features abstracted from natural systems. In their diversity, natural systems contain elements of resilience, persistence, and survival. We can learn from them. Some writers are more adamant. They say we must learn from them. For example, Wright (1974) discussing wildfires in forests wrote: "The survival of man may depend on what can be learned from the study of extensive natural ecosystems." The key word is "extensive." In part it reflects an old forester (Aldo Leopold's) first law of intelligent tinkering: keep all the parts. We may need them sometime. Again, if we can't be good, at least we can be prudent.

Indicator Values

This argument simply recognizes the value of the canary in the mineshaft. Better something else feel the pain before we do. It assumes that we are wise enough to act quickly should the canary die. The most striking examples are local extirpations of species. With the canary dead, a portion of genetic diversity is gone, we have reduced future options, and may have meddled in a way that affects practical survival. The loss of parts tells us that something has gone astray with the larger system and more troublesome losses may be imminent. Those indications are obvious and perhaps too late. Biodiversity can also act as a more distant early warning system.

Because different forms of life sense environmental changes differently, some forms sense or reveal important changes in the environment before we are aware of them. Examples include honey bees as monitors of heavy metal pollution (Ehrenfeld 1976), snakes as indicators of organochlorine pesticides and PCB residues in terrestrial ecosystems (Bauerle et al. 1975), kinked tails in tadpoles revealing pesticide concentrations, climatic change, or acid precipitation (Hillaby 1975; Pough 1976), cancerous growths on fish, egg shell thinning in raptors or fish-eating birds, and others. Nature has provided the mineshaft canary in many forms. The argument for future indicators simply states that we ignore the loss of these forms at our peril. The miner follows the canary.

Values as Blueprints

A useful aphorism for the manager is "if it ain't broke, don't fix it" (e.g., Bunnell 1989). An alternative approach is to improve on natural systems by tinkering in a way that is intended to enhance productivity of a specific resource. The argument for

preserving intact ecosystems with all their diversity recognizes both approaches. Intact systems serve as blueprints to tell us when "it ain't broke" or how the damned thing worked before we lost some of the parts; they can also provide the manager with some guidance in extracting focussed productivity. For those suspicious of tinkering in any form, the blueprints provide another value. For these individuals future uncertainty is very significant. They appreciate, and may fear, the possibility that changes to specific ecosystems can trigger dramatic, uncontrollable changes in the environment. The intact systems represent blueprints for recreating what was lost.

However the argument for intact systems as blueprints is derived, there is evidence of its utility. Most of our recent success at "environmental reconstruction" has relied on information from systems where tinkering was minimal (Bunnell and Williams 1980b).

We Want It

If the preceding reasons are not enough, there is one argument that is sufficient. The public wants biodiversity.

I am aware of no poll that addresses the question specifically, but a recent (1989) Environics poll of Canadians is revealing. Consider three questions within the poll. In answer to "What is the most important use of Canada's forests", 27% of Canadians answered wildlife protection, 25% answered wilderness preservation, and 12% said logging. About one quarter (23%) ignored the choices offered and said "more than one use", reflecting some faith in integrated management. Answering the question "Is it more important to preserve special forest areas or to ensure jobs?" Canadians answered: preserve forests (64%), preserve jobs (23%). In answer to "What is the most important consideration in forest land use decisions?" 63% chose potential environmental impacts and 11% chose potential economic value (an additional 9% chose job creation).

The questions summarized do not address the matter of diversity directly, but they reveal a strong concern for wildlife, wilderness, or environmental values. The concern for diversity is implicit and strongly affirmed.

HOW DO WE RETAIN BIODIVERSITY?

There is no simple answer, but one recent review (Bunnell and Kremsater 1990) addresses the question for forest-dwelling species. For managers there are three broad questions: how to treat single managed stands (100 ha or less), how to treat large management units (about 100,000 to 1,000,000 ha), and how to distribute areas receiving no management action (size, number, relative location).

We have reliable experience only for the first question. Most of the effort to develop integrated approaches to forest and wildlife management has concentrated on single, high-profile wildlife species in small treatment units (e.g., Armleder et al. 1986; Nyberg et al. 1986). The approaches appear successful and because they produce stands of relatively diverse structure will maintain much more wildlife diversity than the

single target species which prompted their development. The harvesting and stand tending prescriptions developed by Armleder et al. (1986) are intended to maintain winter range of mule deer (Odocoileus hemionus hemionus). The retention of some older trees, however, benefits a large number of species, especially cavity nesters which have restrictive habitat requirements. The small-group selection also creates small openings which, together with the large trees, offer excellent habitat for one of Canada's rarest species, the flammulated owl (Otus flammeolus). The silvicultural treatments proposed by Nyberg et al. (1986) to maintain winter range of black-tailed deer (Odocoileus hemionus columbianus) in managed stands likewise will maintain considerable wildlife diversity.

Where uneven-aged management is appropriate, these silvicultural prescriptions can be extended over large areas with little modification to the prescription. Where even-aged management is appropriate the second question becomes important: how should the experience acquired with silvicultural prescriptions for individual stands be applied over large areas? Current evidence (Bunnell and Kremsater 1990) suggests three broad constraints: 1) integrated management in individual stands can preserve some diversity but not all, 2) distribution of stands through space and time will influence wildlife diversity over a large area, and 3) some forest will need to be reserved from intrusive management. Their reviews led both Thomas (1979) and Brown (1985) to conclude that it is possible for a managed forest composed of a mosaic of stands to support more wildlife diversity than would an old-growth forest. Franklin and Forman (1987) estimated that the peak in numbers of wildlife species would occur when about 30 to 50% of the forested landscape was cut. I believe Thomas and Brown are correct, but am aware of no rigorous evaluation of the appropriate mosaic or proportions of different seral stages.

The third constraint likewise looms large -- somewhere, some amount of forest cover will have to be set aside from extractive management. Such reserves may be part of planning at the watershed level as well as at the provincial or national level. There is abundant evidence that larger or old-growth resident species are diminishing in distribution and numbers (Bunnell and Kremsater 1990). Commitment to maintaining diversity will have to set aside areas free of intrusive management. Unfortunately, the principles of island biogeography are not universal and have inherent uncertainties. Management to preserve certain areas will be highly risk-laden. Factors to consider and components of that risk are reviewed by Bunnell and Kremsater (1990).

In summary, we are learning how to develop integrated approaches to forest-wildlife management and have several success stories. Although developed for high profile species, these approaches can be extended to maintain diversity but will not capture it all. Some areas will have to be reserved from timber harvest but we have few firm guidelines on how those areas should be established. We do know that some of these areas will have to be large, but the required numbers and distribution are unclear. It also is unclear what portions of particular watersheds or larger management units will have to be deferred from harvest, or for how long, to maintain wildlife diversity.

CONCLUSIONS

Subspecies are a convenient unit for assessing biodiversity because they are recognizable and represent real genetic diversity. For a north temperate nation Canada contains high wildlife diversity and most of it is forest-dwelling. Because of its diverse forest types, British Columbia has the greatest wildlife diversity in Canada. British Columbia also is one of very few areas left in north temperate regions that contain intact systems of several large predators and their prey species. Significant portions of both the bird and mammal fauna are cavity-dwelling and are restricted to mature or old-growth forests.

There are compelling social, moral, practical, and economic reasons for maintaining biodiversity, not the least of which is that the public wants it. We have a growing edge on joint forest-wildlife management which has produced success stories and we should continue to nourish those activities. Integrated management, however, will be insufficient and some forested areas will have to be removed from timber harvest. Unfortunately, available theory on the amounts and location of reserved areas does not provide unequivocal guidance. That situation is daunting only to the risk adverse. As Bunnell and Kremsater (1990) noted we have taken the first steps and begun to define the problem. Our success at integrated management indicates that we have the talent. The public is creating the political will. We can maintain biodiversity in our forested systems.

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INTEGRATING HABITAT NEEDS OF MOOSE WITH FOREST MANAGEMENT - HOW WELL ARE WE DOING?

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ABSTRACT

Moose vary seasonally and geographically in their habitat requirements. A knowledge of these differences is important as they influence the focus of habitat management and protection activities. Translating population objectives into estimates of habitat supply are currently difficult to accomplish for three main reasons. First, suitable biophysical inventory is lacking for much of the province. Second, the linkage between population levels and habitat supply is incompletely understood. Third, the options to manage forests for moose are limited by current planning processes. The first two difficulties are being overcome through on-going inventory and research, although hampered by lack of funds. Overcoming the third problem will require major adjustments in our current approach to integrated management so that all forest resources are represented fairly.

INTRODUCTION

The management of moose populations has three principal components - providing sufficient habitat, regulating human use (both hunting and non-consumptive), and controlling losses from other factors such as predation, disease and accidents (Page 1987). In reality, these components are inter-connected, but in this paper we focus on the first component, habitat, and in particular on the integration of moose habitat needs into forest resource management.

Our focus on forestry is based on the recognition that the key to successful management of moose habitat is through forest management. This premise was stated succinctly over ten years ago by Thomas (1979), and is paraphrased for this paper, as follows:

> Large scale moose habitat management goals must be accomplished through timber management because timber management:
>
> * affects many hectares
> * is well financed
> * dramatically affects moose habitat
> * has great impact on moose,
>
> while moose habitat management:
>
> * affects few hectares
> * has little financing
> * has little influence on moose habitat
> * has little present impact on moose.

Although this idea was originally described for deer and elk in Washington and Oregon, it applies as well to moose in British Columbia.

This paper has four parts. First, we briefly describe habitat requirements of moose. Next, we describe the limiting habitat characteristics for moose. Then, we discuss the determination of habitat supply and how concerns regarding this supply are tied into forest management. Finally, we conclude with ways to resolve present problems facing integrated forest management in British Columbia, with particular reference to moose and timber. It is our contention that forest management objectives currently drive the integration process to the detriment of other resources such as moose, and that integration of planning processes at all levels is required in order to optimize resource management as a whole.

HABITAT REQUIREMENTS

Habitat requirements of moose vary both seasonally and geographically, as recently summarized for British Columbia by Eastman and Ritcey (1987). Further information will be included in the Provincial Moose Management Plan (Hatter et al. in prep.). These documents reflect a growing appreciation that moose (as well as other forest resources) must be managed ecologically.

Habitat requirements are usually considered in terms of the need for food and cover. For food, moose are regarded as "concentrate selectors" because they select vegetation that is low in fibre with easily digestible cell contents. Although moose eat a wide variety of shrubs, herbaceous plants and even cereal crops and lichens, they tend to be quite selective for both plants and plant parts which they eat (Eastman and Ritcey 1987). Consequently, the available supply of food from a moose's perspective is probably far less than that judged by a manager.

Except for general patterns, the seasonal diet of moose is incompletely known for most of the province. Winter diet consists mostly of deciduous shrubs, but conifers such as subalpine fir, and western red-cedar become increasingly important as winter progresses. Also in late winter, moose eat arboreal lichens and strip bark from aspens. In spring, moose continue browsing but also eat the highly digestible tips of newly emerging herbs. In summer, moose strip shoot tips and leaves from deciduous shrubs and forage on aquatics, sedges, grasses and tips of herbs like fireweed. Once herbaceous material dies back and after leaf-fall, moose return to a diet primarily comprised of deciduous shrubs.

Moose use three main types of cover: interception cover, security or hiding cover, and thermal cover. Especially in areas of heavy snowfall, moose require cover provided by an overstory canopy of conifers which intercepts falling snow and so reduces snow depth on the ground. Shallow snow has two principal advantages for moose: walking is easier and rooted forage is more available.

Throughout the year, moose require hiding or security cover to conceal or otherwise protect them from other moose and predators. The key features of security cover are that it be sufficiently opaque and tall enough to conceal a moose. Dense stands of young conifers provide good security cover, while the less dense

pole-sapling and older forest stages provide comparatively poorer hiding cover. An operational definition of hiding cover is lacking for moose, but as an example, security cover for Rocky Mountain elk has been defined as vegetation capable of hiding 90 percent of a standing adult elk at a distance equal to or less than 61 m (Thomas 1979).

Although moose are well adapted to cold winter conditions, thermal cover can be important in conserving energy. Forest stands vary in their thermal environments according to their stand characteristics, but in general, radiational heat losses are less under forest canopies than in a clearcut. Temperatures and wind speeds inside forest stands are less extreme than in openings. These climatic differences may be used by moose to moderate temperature extremes and winds, and so reduce energy losses.

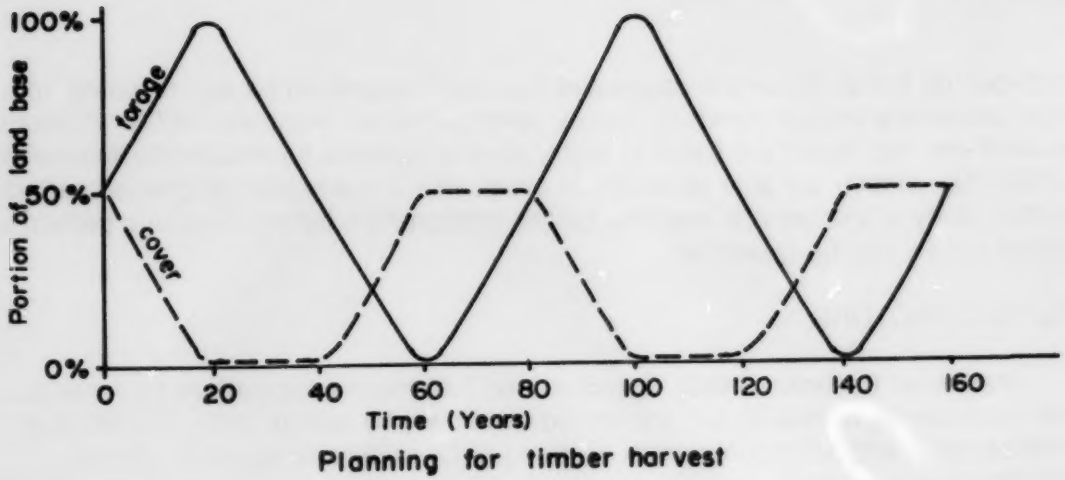
Probably the main factor influencing habitat supply for moose is the pattern of vegetation over space and time. The conventional statement for moose is that a mix of older and younger forests stages is needed to produce good habitat. Since each stage varies in its ability to meet life requisites, a mix is needed within each individual's home range. Since forest succession, timber harvest, silvicultural regimes, fire, disease and site features cause stands to vary over time and space, the management challenge is to provide the most suitable mix of successional stages at the appropriate scale and over the long term. This task is neither simple nor easy and remains largely unsolved.

Managing for pattern is focused mainly on winter ranges because wildlife managers assume that winter is the most critical season for moose. Pattern has two aspects: proportion and scale. As an example of proportion, the following proportions of timber age classes could be guidelines recommended in areas where snow interception cover is required:

Younger stands (0-40 years)	33%
Intermediate stands (40-80 years)	33%
Older age classes (80-120 years)	33%

The impact of this guideline on timber harvesting rates contrasts sharply with a more typical approach in which large areas are cut at rotation age. These differences pose major challenges when forest and moose managers discuss requirements of their particular resources. Figure 1 compares the availability of forage (age class 0-40 years) and interception cover (age class 80-120 years) under two logging regimes in a hypothetical planning area. In the first, the entire area is cut under a two pass system that is completed by year 20. The second shows the proportions of forage and cover resulting from a prescription in which one-third of the area is logged every 40 years. The definitions of forage and cover are somewhat arbitrary but the potential difference between integrated and nonintegrated approaches to management for moose and timber are clear.

The aspect of scale or size of patches is not well quantified. Evidence from



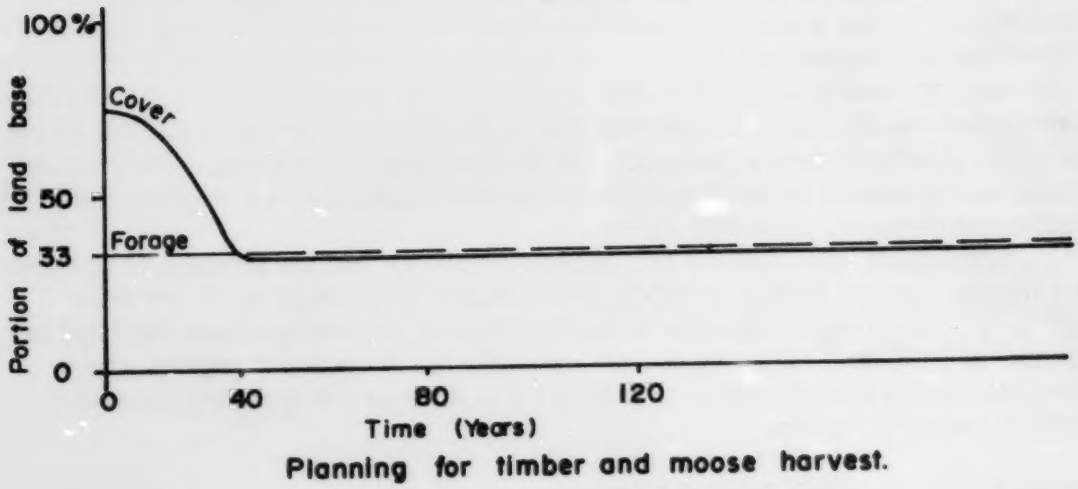


Fig. 1. Hypothetical changes in the supply of forage and interception cover for moose under two timber harvesting scenarios.

north-central British Columbia suggested that the fine-grained pattern resulting from older selectively logged stands is heavily used by moose (Eastman 1977). Alaskan researchers also report the value of highly diverse habitats for moose (LeResche et al. 1974). Yet, moose are also abundant in areas with a much coarser-grained pattern. Further study of this topic is required before relationships between logging pattern and habitat supply can be quantified.

LIMITING FACTORS

Peek and Eastman (1983) hypothesised that moose populations increase as their food supply increases but are limited eventually by factors such as predation, disease, or intraspecific competition for forage. Considerable recent evidence indicates that wolf predation or human harvest can limit moose numbers below that set by food supply (Bergurud et al. 1983), but ultimately the available forage supply will set the upper limits for the size and the productivity of populations. Figure 2 attempts to show the relationship between the harvest and habitat related limiting factors.

Food supply is a key factor in the winter ecology of moose. Since a moose's winter diet consists largely of deciduous shrubs, the seral stage is a key factor in determining forage availability. Working in Alberta, Renecker and Hudson (1986) found that, during January, the consumption rate for an individual moose did not increase appreciably once the usable biomass exceeded about 500 kg/ha and that the critical biomass of usable forage was 150 kg/ha. Critical biomass is defined as the biomass at which intake is reduced to 50% of the asymptotic value. Thus moose likely require access to foraging areas where the usable biomass is greater than 150 kg/ha and preferably near 500 kg/ha.

Snow depth and heat are two aspects of climate that are critical limiting factors for moose. Moose appear to handle snow depths up to about 40-50 cm without difficulty; movement is impeded at depths of 60-70 cm; and severely restricted at depths of >100 cm. Thus moose are generally not abundant in regions where persistent snow accumulations exceed 1-1.5 m such as the mainland coast and interior "wet belt" forests.

HOW MUCH HABITAT DO WE NEED?

Ideally, the amount of habitat needed is defined through examination of the demand for moose and the supply of habitat. Demand is expressed eventually in terms of moose population objectives, while the supply is assessed by examining the current (suitability) and long term capacity (capability) of the habitat to produce moose habitat, and by evaluating the effect of other resource management activities on the options of supplying habitat.

While the translation of public demand into moose population objectives is relatively straightforward, there are three reasons why it is difficult to the estimate the amount of habitat required. First, the needed biophysical inventories of habitat capability and suitability are not widely available for the province. Second, the linkage

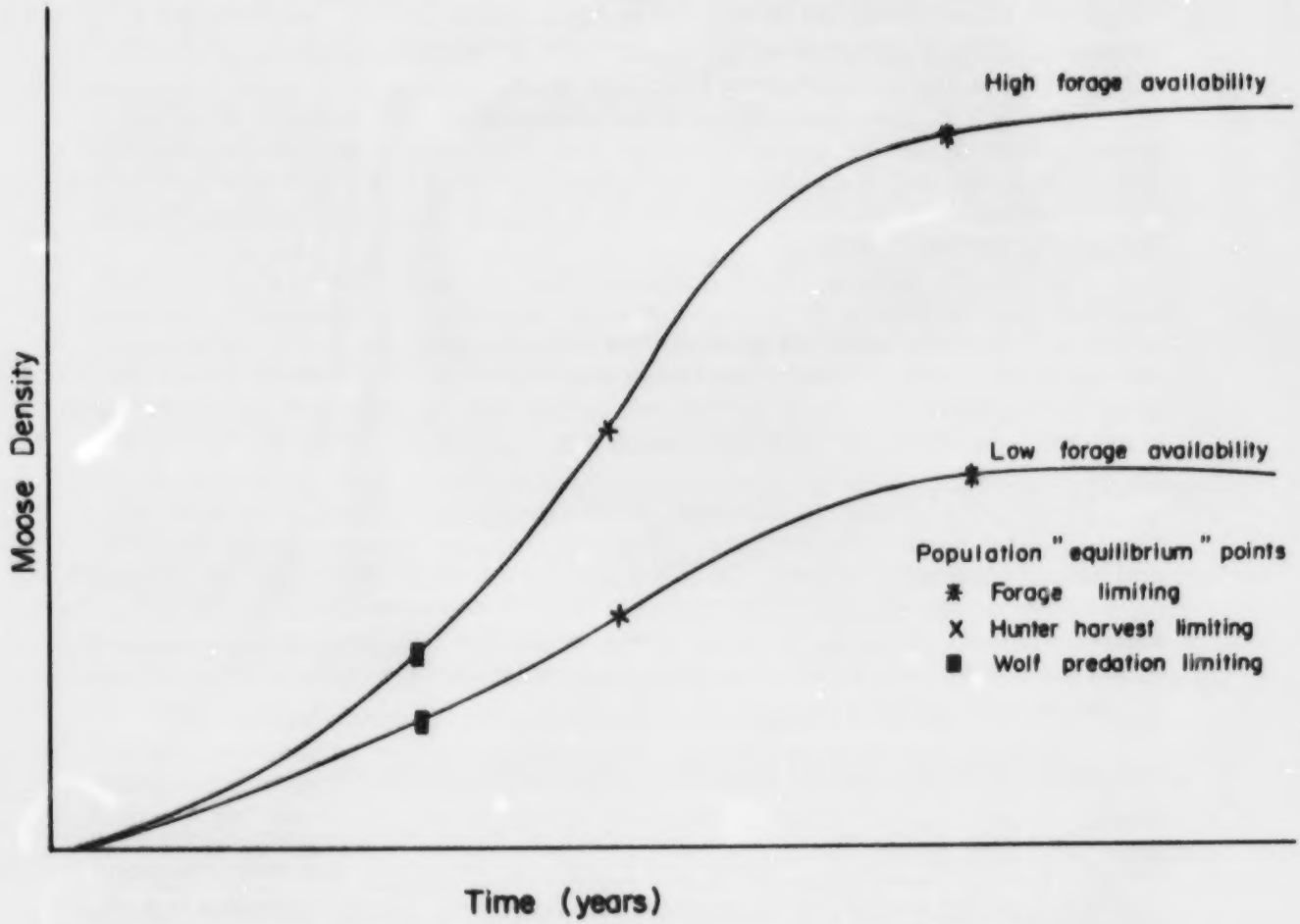


Figure 2. Hypothetical Relationship between Moose Density and Limiting Factors.

between habitat and population levels is neither well understood nor quantified. Third, the lack of an integrated planning process for forest resources often precludes a realistic assessment (and attainment) of options to produce the required amounts of suitable moose habitat.

Biophysical inventories classify the land's capability to produce moose and other species. This knowledge enables managers to determine the location and extent of high capability areas and so direct habitat management efforts to those that are likely to have the greatest pay-off. For planning purposes, biophysical inventories at scales of 1:50,000 or smaller are most useful. Unfortunately, much of the province's moose ranges are either unmapped or mapped at inappropriate scales. This hampers a manager's ability to allocate habitat management activities and encourages a more conservative approach when trying to protect areas.

The ability to predict the linkage of population levels and habitat is an active research area for several ungulate species, e.g., black-tailed deer, elk and mule deer. The general approach is to estimate the habitat's capacity to support ungulates based on bioenergetic or nutritional considerations, analogous to estimating range carrying capacity for domestic livestock.

The lack of a suitable planning process needs to be addressed as the process sets the range of options moose managers can consider. The importance of habitat supply to moose management parallels that of timber supply to forest management. Managing the supply of habitat and timber is fundamental to successful moose and forest management programs, respectively. Many factors determine how much habitat is needed and where it should be in space and time and the same can be said for timber.

Over most of the range of moose, forest management "drives" the supply of moose habitat, largely irrespective of the supply forecasts based on public demand and habitat capability analyses. Up to the present therefore, moose habitat managers have had to be opportunistic and "make the best" of decisions based on managing the supply of timber. Thus, at the present time, population objectives must be updated to reflect the current and projected suitability that result from the consequences of timber harvest and silvicultural practices.

THE NEED FOR INTEGRATED FOREST RESOURCE PLANNING

The supply of moose habitat is dependent on forest management. Consequently the interrelationship between habitat and forestry is important - and their integration is crucial to meeting moose habitat management objectives. Since integration is such a critical link in providing for habitat supply, it is instructive to comment on the effectiveness of current legislation, policy and planning processes in achieving integrated management.

Legislation, Definitions, and Policy

The legislative basis for integrated management lies primarily in the Ministry of Forests Act that requires "consultation and cooperation with other Ministries and agencies of the Crown and with the private sector" (Section 4 [c]); and in the Forest Act, that indicates that Provincial Forests shall be assessed and managed for several

purposes including wildlife. The major weakness of these Acts is that the terms "integration" and "coordination" are undefined (Harcombe 1984). Also, although wildlife-related legislation implicitly provides opportunities for integrated management, it is not specific.

There are many definitions of integrated forest management, but one current definition proposed by the Forest Service is "A decision-making process which identifies and considers all resource values along with economic, social and environmental needs and assigns resource management emphasis based upon the relative merits of various resource uses. Integrated management can produce a mosaic of single, multiple or sequential uses. It does not mean providing for all uses in all areas".

The Association of British Columbia Professional Foresters provides a policy statement which strongly favours integration of fish and wildlife objectives . The Association's charter states: "Fish and wildlife management objectives shall be identified and incorporated into forest management programs. Production and protection of fish and wildlife values should be commensurate with the management levels applied to other resource values".

Thus forestry legislation, policies and definitions for integrated management recognize the need to consider moose and other forest resources in planning the development and use of forest resources. The major problem seems to be in their implementation in planning processes.

Forest Planning Processes

Forest policies are implemented through a number of Ministry of Forests planning levels. Ideally, the trade-offs between the needs of timber and moose management should be resolved at the level of planning appropriate to the type of decision as described below:

Timber Supply Area Plans

The regional objectives for moose and moose habitat address long term needs to maintain, enhance or expand moose habitat. These needs are appropriately addressed in planning the Annual Allowable Cut (AAC) at the level of the Timber Supply Area. Generally, the higher the AAC is for a Timber Supply Area, the fewer the options for integrated management of timber and moose habitat (and other wildlife species). This point is especially important where the needs of moose and other wildlife involve the deferral or deletion of older forests from AAC determinations, such as in high snowfall areas of the Province.

When the AAC's for Timber Supply Areas are re-analyzed, increasing opportunities exist to explore the consequences of considering needs of moose and other resources. For example, one option could include consideration of the long term forage and cover needs for moose, through such practices as reducing cut block size, increasing the number of logging passes from two to three, or extending rotations.

Five Year Development Plans

These plans provide a means for the Wildlife Program to examine general cut block locations and access development for each logging company. Input can include recommendations to maintain cover in key areas by reducing cut block size, deleting blocks in particularly sensitive areas, or routing access away from sensitive areas.

Cutting Permit Referrals

These referrals provide similar opportunities to those presented by the five year plans. However, the final cut block design allows more detailed input on the location and size of clear cuts. This may provide opportunities to retain buffer strips around wetlands or other key winter foraging areas.

Access Plans

These plans are mandated under the Access Planning Protocol signed by the Ministry of Environment and the Ministry of Forests. They have a less general coverage than the plans described above. The areas planned are portions of Forest Service Districts which are sensitive to access development. Moose are vulnerable to overharvest if access is excessive on fall ranges. Recommendations from the Ministry of Environment's Wildlife Program can include closure of some existing roads where the density of roads provides excessive access on fall ranges or would produce excessive disturbance on winter ranges. Closure of roads which provide dual access from two major population centres are also candidates for physical closure. Deactivation of roads may also assist enforcement of hunting regulations in some cases by, for example, reducing the number of access routes into a particular area or by closing some roads on winter ranges where moose are concentrated and vulnerable to poaching.

Wildlife Planning Processes

Moose management objectives are set by the Ministry of Environment through the Wildlife Program. The forestry related activities of access, succession and logging of winter ranges are considered to be of high concern to managers in subboreal lowland and upland zones and portions of other zones where moose are abundant.

The Wildlife Program also has a number of planning programs which deal directly with moose habitat and population management. The regional plans provide objectives for population size, harvest, and other recreational uses. The provincial species plans set objectives for the province based on the regional plans and provincial considerations such as the projected distribution of demand for various recreational opportunities based on moose in various parts of the province. The implementation of these plans with respect to habitat management takes place largely through the Forest Service planning processes. These species plans are not formulated at the operational level, therefore much additional planning is done as

needed in order to provide input to the lower levels of the Forest Service planning systems.

Currently, the lack of policy and procedures to implement the integrated resource management section of the Forest Act severely restrain the ability of managers to optimize management of forest, wildlife and other resources as a whole. Operational Integrated Resource Management is done "at the planning table", with little direction to the participants other than the Forest Act. This results in moose and other wildlife being considered only as constraints to timber production. Considerations for moose or other wildlife species may be allowed to reduce an AAC by up to five percent, but it is unlikely that the reduction would be allowed to reach 50% level for a Timber Supply Area, even if this did produce the maximum benefit from all the resources being managed. As described by Fox (1985) at an earlier wildlife-forestry symposium, the superior status of the Forest Service in the final decision is a major constraint in accomplishing truely integrated resource management. Presently, the gains that have been made for wildlife have resulted from the general intent of the Forest Service to undertake integrated resource management and the interest and goodwill of some staff towards wildlife.

RECOMMENDATIONS FOR IMPROVEMENT

The level of joint planning between the Ministry of Forests and the Ministry of Environment as it affects moose and other wildlife species has improved substantially over the last 15 years. It is our contention that a fully rationalized system of Integrated Resource Management requires changes at the legislative, policy, and planning levels because:

1. Ministry of Environment goals and objectives are not backed by a strong legislative mandate, especially for such goals as moose population and harvest levels. In addition, these objectives are not closely tied to habitat capability and suitability.

2. The Ministry of Forests does not have the required policies and procedures in place to provide for the application of section 4(c) of the Ministry of Forests Act. For example, there is no direction provided on how to measure the "optimum social and economic benefit". Without this direction, it is difficult to meaningfully consider the needs of moose or other wildlife species at the TSA and other planning levels.

Some suggestions to resolve these limitations are:

1. Improve the technical information base to aid evaluation of trade-offs. What are our best estimates of the impact of various forest management practices on moose habitat and ultimately on moose availability? This paper attempts to assemble the basic information related to moose and forest management, however, much of the detailed information required to

assess moose and forest management is not available. In many cases this assessment will take the form of risk management since the estimates of impacts will often be in the form of probabilities rather than precise relationships. This is not a failing of either biologists or foresters but relates to the inherent complexity and chaotic nature of biological systems.

2. Develop means to measure and compare social and economic benefits of timber and wildlife. B.C. has a resource based economy that is heavily dependent on the timber resource. The importance of wildlife is significant and will likely increase as a result of its connection to tourism. It is crucial that wildlife values, including moose values, are considered in measurable and comparable terms to timber values.

3. Integrate wildlife with timber at the legislative, policy , and higher planning levels. These changes will give direction at the lower planning levels. Currently, wildlife considerations are viewed as constraints on forestry activities. What are needed are ways to examine the land base and estimate the optimal social and economic benefits which can be derived from it over short and long terms.

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INTEGRATING FORESTRY AND CARIBOU MANAGEMENT

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ABSTRACT

During winter the mountain caribou ecotype of southeastern British Columbia depends on arboreal lichens while the northern ecotype depends mainly on ground forage. For both ecotypes, concerns about forestry focus mainly on three issues: the impact of logging on winter ranges, the effects of road access on populations, and the effects of habitat alterations on predator/prey relationships.

Opportunities exist for foresters and wildlife biologists to develop management strategies that allow timber harvest while maintaining winter range values. Those strategies may include protection of some key winter ranges, the use of special harvesting and stand tending methods, extended rotations, and access control. Methods of enhancing the development of arboreal and terrestrial lichens in second growth stands are currently under investigation. Because caribou avoid predators by spacing themselves out over large areas, managers must maintain large areas of suitable habitat for caribou.

INTRODUCTION

All native caribou living in British Columbia belong to the woodland subspecies, Rangifer tarandus caribou. However, managers find it useful to distinguish between two ecotypes (fig 1). The mountain caribou inhabits a high-snowfall zone in southeastern and east central British Columbia, and feeds mainly on arboreal lichens during winter. The northern caribou inhabits areas of lower snowfall in northern and west central British Columbia, and is able to dig through snow for terrestrial forage (crater) most of the time during winter. For both ecotypes, concerns about forestry focus mainly on three interrelated issues: the impact of logging on winter ranges, the effects of road access on distribution and mortality rates, and the effects of habitat alterations on predator/prey relationships. These and other impacts are complex and cumulative; they can operate in concert in ways that are difficult to predict.

MOUNTAIN CARIBOU

The seasonal habitat relationships of mountain caribou have been investigated in a series of radiotelemetry studies (Antifeau 1987; Simpson and Woods 1987; Rominger and Oldemeyer 1989; Servheen and Lyon 1989; Watts 1989; Seip 1990; Seip, in prep.).

Mountain caribou typically summer in high, mountainous terrain, where they feed on herbaceous vegetation. Most summer ranges are located outside the merchantable timber zone. Even if logging did occur, it would be unlikely to affect summer habitat use.

Figure 1. Distribution of northern caribou (cross-hatched) and mountain caribou (dotted) ecotypes in British Columbia.INTEGRATING FORESTRY AND CARIBOU MANAGEMENT

The most characteristic winter ranges of mountain caribou are subdued subalpine plateaus. When snow conditions permit, caribou use the upper, open-canopied portion of the Engelmann Spruce - Subalpine Fir (ESSF) Zone. The snowpack, which may be 3 m or more deep, allows them to reach the arboreal lichens growing in the lower portion of the canopy. When the snowpack in the ESSF is not supportive, caribou are more likely to be found at lower elevations -- the ecotone between the ESSF and the Interior Cedar - Hemlock (ICH) Zone, or the ICH itself. At those elevations the major forage items are low evergreen shrubs (especially Paxistima myrsinites) and arboreal lichens available as litterfall and on windthrown trees. Use of the ICH seems to occur more regularly in the eastern, more mountainous portion of the mountain caribou's range (the Rocky Mountain and Columbia Mountain Physiographic Regions described by Holland [1964]). In the Quesnel Highlands and the caribou ranges immediately east of Prince George (the Interior Plateau Physiographic Region), use of lower elevations -- the ICH and the Sub Boreal Spruce (SBS) Zone -- occurs less frequently. The winter ranges of mountain caribou are mostly located within merchantable timber, and have been the subject of conflicts between forestry and wildlife managers.

During spring, some caribou continue to use the snow-covered habitats in the ESSF while others apparently seek green vegetation at lower elevations, in clearcuts or on slides. Cutblocks have little value as spring foraging areas once they have been overgrown by shrubs or conifers. The impact of forestry activities on spring range is not usually a major concern, although local shortages of spring range could occur where mid-seral stands were extensive.

Wildlife managers have dealt with winter range concerns in several ways. In the past, they have counted on large areas of low-value timber, such as decadent cedar-hemlock and high-elevation subalpine fir, remaining unlogged for some time. However, the increasing demand for wood fibre and changing standards of merchantability are increasing the pressure to log stands that were formerly considered secure.

Where logging has been proposed in important winter ranges, biologists have tried to institute reserves. Information obtained from radio telemetry studies can provide important input to Timber Supply Area planning. For example, Seip (in prep.) compared the availability and use of timber types in the Quesnel Highlands and found that radio-collared caribou significantly preferred subalpine fir-spruce types to types in which spruce was the leading species. His data were used in the development of the Options Reports for the Quesnel and Williams Lake Timber Supply Areas.

Biologists are also beginning to consider whether, in some cases, there are ways of managing forests that will allow timber harvesting and also maintain habitat values for caribou. Taking that approach, biologists analyze the habitat attributes that are apparently most important to caribou in the old-growth forests they use, and attempt to reproduce those key attributes in managed stands. They assume that if habitats are to maintain populations in the long term, the attributes that can be functionally linked to survival must be maintained, regardless of whether those attributes are currently limiting populations.

Table 1 shows preliminary ratings of key attributes of winter ranges in various biogeoclimatic zones, as inferred from studies in which radiocollared caribou were trailed on the ground in winter (Antifeau 1987; Rominger and Oldemeyer 1989; Simpson et al. 1985). That analysis indicates that in the ESSF zone, it is important to maintain lichen production and to protect caribou from access. At lower elevations, it may also be important to maintain litterfall and sporadic blowdown as sources of arboreal lichens.

In a Ministry of Environment program known as "Mountain Caribou in Managed Forests", special techniques for integrating forestry with caribou management are being tried. A variety of partial cutting methods are being used, on a trial basis, to maintain a residual stand of mature, lichen-bearing trees. Those include several kinds of single tree selection, group selection, and very small patch logging. Special stand tending methods can also be used to enhance the production and availability of arboreal lichens. In some young stands, the microclimate for arboreal lichens can be improved by thinning. In midseral stands that already support some lichen, girdling can be used as a thinning method; the standing dead trees provide a good substrate for lichens and a future source of litterfall and blowdown.

Where extensive harvesting or wildfires have occurred, limiting the opportunities to apply most special management techiques, it may still be possible to reintroduce arboreal lichens to young stands. Methods for inoculating young trees with lichen fragments have been developed for coastal deer winter ranges, and will be applied to caribou habitat as part of the Mountain Caribou in Managed Forests program (Enns 1990).

Despite the potential of special techniques of harvesting and stand tending to maintain forage lichens, there is still a need to reserve some areas from logging altogether. First, the long term success of the special management trials in maintaining caribou habitat will be unknown for many years. Second, logging affects caribou by creating road access as well as by altering habitats. The relative importance of those two impacts is not clear, and probably varies geographically. If managers are unsuccessful either in controlling access or in maintaining suitable vegetation for caribou, integrated management could fail. The strategy of the Mountain Caribou in Managed Forests program is to define three kinds of management zones for caribou: one that is reserved from logging altogether, one in which special management techniques are applied on appropriate sites, and one in which there are no special constraints due to caribou.

NORTHERN CARIBOU

The largest caribou populations in British Columbia are of the northern ecotype. Major radiotelemetry studies have been reported by Hatler (1986) and Cichowski (1989). The studies of Edmonds and Bloomfield (1984) in west central Alberta are also pertinent.

The most characteristic summer ranges of northern caribou are alpine and subalpine habitats, though there is some use of lower elevations. Some populations

Table 1. Estimated importance of key attributes of caribou winter range in various biogeoclimatic zones (Stevenson 1990)

Attributes	ESSF	ICH/ ESSF	ICH-M[1]	ICH-P[2]	SBS
Arboreal lichen production	H	H	H	M	M
Blowdown and litterfall	L	H	H	M	M
Snow interception	NA	L	M	L	L
Rooted forage production	NA	L	M	L	L
Access management	H	H	H	H	H

L - low; M - medium; H - high; NA - not applicable

1/ ICH in Rocky Mountain and Columbia Mountain Physiographic Regions

2/ ICH in Interior Plateau Physiographic Region

calve primarily at high elevations, whereas others disperse throughout forested habitats as well. The impact of forestry on summer habitat use is minimal.

Northern caribou exhibit two major patterns of winter habitat use. The primary winter habitats for most northern caribou are mature lodgepole pine or pine/spruce forests with abundant terrestrial lichens. Dry meadows are used when the snow depth is low or moderate, but are abandoned during periods of deep snow. Treed muskegs and wetland complexes are also used. Under certain snow conditions, northern caribou may switch from terrestrial forage to arboreal lichens. Immature forests (<80 years) are avoided.

Alternatively, northern caribou may winter on alpine slopes with minimum snow accumulation. In the Rainbow Mountains of southern Tweedsmuir Park, the population regularly winters in alpine habitats (Cichowski 1989). More commonly, the alpine is used by a small proportion of caribou throughout the winter, or by many caribou for a short time. In Spatsizi Park, movement to the alpine apparently resulted from snow conditions below treeline that restricted the animals' mobility or foraging opportunities (Hatler 1986).

During spring migration, caribou tend to use low elevation movement routes and to feed on green vegetation in openings. Some Itcha-Ilgachuz caribou were located in or near snow-free clearcuts during spring (Cichowski 1989). Forest harvesting is not likely to negatively impact spring range use, provided that mature forest movement routes are maintained.

Key habitat attributes for the the winter ranges of northern caribou include abundance of terrestrial lichens (and, to a lesser extent, arboreal lichens) and restricted access. Snow interception seems to affect the selection of forested rather than open areas, but does not necessarily determine habitat selection within forests (Cichowski 1989).

Northern caribou select feeding sites with high terrestrial lichen abundance (Edmonds and Bloomfield 1984; Cichowski 1989). Terrestrial lichens are most abundant on sites with well-drained soils, in meadows or in open-canopied forests >80 years. Often, those are poor or low forest sites. Unlike arboreal lichens, terrestrial forage lichens are characteristic of mid-successional stages. In stands of fire origin they are often most abundant from about stand age 60 to stand age 120 (Maikawa and Kershaw 1976; Viereck and Schandelmeier 1980), but their successional history after logging is not as well known.

Restricted access is a key habitat attribute for northern caribou, as it is for mountain caribou. In west central Alberta, human-caused mortality, which included mortality from collisions and from hunting, was directly related to road development (Edmonds 1988). The presence of packed trails into winter ranges can also improve access for wolves (Bergerud 1978); J. Edmonds (pers. comm, 1 October 1989) discontinued using snowmobiles for access into winter ranges during her studies because wolves regularly used the trails as routes into the caribou ranges.

Several broad approaches have been taken to the problem of forest harvesting in winter ranges of caribou that depend on terrestrial lichens. Forest harvesting results in a mosaic of stands of different ages. Should the mosaic be a fine-grained one or a

coarse-grained one? Edmonds and Bloomfield (1984) observed that caribou in their study area used small clearcuts (<2 ha) but not larger ones, and that 87% of all feeding and bedding sites were within 50 m of cover. They developed guidelines calling for small clearcuts, intended to mimic the openings that are naturally used by caribou.

An alternative approach is based on the observation that caribou tend to abandon areas where forest harvesting occurs, and on the concern that forest harvesting alters predator-prey relationships to the disadvantage of caribou (Darby and Duquette 1986). Accordingly, some managers have recommended that large areas (e.g. 100 km^2) of continuous habitat be maintained as winter range. To minimize the dispersion of human activity, they are willing to accept the consolidation of logging into large progressive clearcuts (Ontario Ministry of Natural Resources, in prep.).

Managers have been hampered in their ability to develop management strategies by uncertainty about the time required for terrestrial forage lichens to recover after logging. The difference between a 20-year and a 60-year recovery period has major impacts on the scheduling of forest rotations. It is also important to know how cutblock size affects the recovery time of lichens. There is a need to review the literature on terrestrial lichen succession and to assess its relevance to British Columbia winter ranges.

Managers have begun to consider whether there are ways of managing the winter ranges of northern caribou that will accelerate their recovery after logging. In an innovative project under way in the Chilcotin Plateau, the effects of various timber harvesting methods on terrestrial lichens are being investigated, as well as the feasibility of transplanting terrestrial lichens from one area to another (Enns, in prep.).

HOW MUCH HABITAT IS NEEDED?

Managers need to know how much habitat to provide. Unfortunately, that question cannot be answered by calculating the annual production of available forage.

Bergerud (1980) and Bergerud et al. (1984) have argued that the major habitat variable affecting caribou numbers is space. Biologists observe that caribou have large home ranges; that they often use different seasonal ranges in different years; and that their distribution in forested habitats is generally dispersed rather than concentrated. The use of large home ranges allows caribou to select habitats offering the optimum combination of snow conditions and food availability; to select habitats that give them an advantage over predators; and to disperse themselves widely, increasing searching time for predators. The ability of caribou to space out as a defense against predation is even more important where logging results in increased numbers of alternate prey species, such as moose and deer, that can sustain predator populations.

Managers must think in terms of providing large areas of suitable, forage-producing habitat for caribou. In some cases, that can be accomplished best through habitat reserves and extended rotations. There is also a place for special management techniques that accelerate habitat recovery. The more biologists and

managers learn about creating second growth stands that will function as caribou habitat, the more flexibility they will have in developing management strategies that provide for both caribou and timber resources.

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MANAGING FOR MARTEN WINTER HABITAT IN INTERIOR FORESTS OF BRITISH COLUMBIA

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ABSTRACT

Marten are found throughout the forested regions of British Columbia. They are active year round, however winter is their critical season due to reduced foraging opportunities, restricted mobility and increased thermoregulatory costs. Marten habitat needs relate to their winter life requisites which include food, foraging sites, resting and maternal den sites and cover.

Although traditionally viewed as an "old forest" dependent species we feel that marten should be able to successfully use second growth stands provided they are suitably managed. Recommendations are made, based on current understanding, for harvesting treatments, maintenance of coarse woody debris in cut areas, rate of cut and cutblock layout.

INTRODUCTION

The marten (Martes americana) is a medium sized member of the weasel family (Mustelidae) found across the boreal forests of North America. They are found throughout most of British Columbia, and are generally seperated into interior and coastal forms.

Aside from their inherent ecological importance, marten have been the mainstay of the B.C. trapping industry with harvests the past few years reaching as high as 40,000 annually for a raw fur value of over $3 million dollars. The majority of this harvest is taken from interior forests.

Marten are mostly carnivorous animals, preying mainly on microtine rodents (especially voles) but also using snowshoe hares, squirrels, other small animals, and carrion when available. Vegetation is rarely eaten, though berries may be important in late summer and fall.

Marten have traditionally been associated with mature coniferous forests. We believe that they can make effective use of immature forests provided suitable habitat features are present. They are typically solitary animals except for females with young or during the breeding season. Most adults will form territories that they defend from members of the same sex, and the size of home ranges varies with habitat productivity and social factors. Home ranges reported in the literature range from 0.8 km^2 to 8.4 km^2 for adult females and 2.0 km^2 to 15.7 km^2 for adult males (Strickland and Douglas 1987). In a given area, male home ranges are typically twice the size of females.

HABITAT REQUIREMENTS

Marten, like all animals, have certain basic life requisites, including prey and suitable foraging sites, resting and maternal dens, and cover (security and thermal).

Winter is considered the critical season for marten. This is when habitat selection is most pronounced, foraging opportunites are most limited, mobility restricted, and thermoregulatory costs highest (Raine 1983, Hargis and McCullough 1984, Buskirk et al 1988). For this reason we address winter habitat requirements and maintenance in this paper. We also restrict our discussion to interior forests, as coastal marten may have different requirements (Nagorsen et al 1989).

Although marten may use a variety of different prey, microtine rodents make up the bulk of their winter diet (table 1). Site productivity and the availability of security and thermal cover (in the form of coarse woody debris) for microtines are likely important factors determining prey abundance (Raphael 1988).

Marten foraging sites are typically subnivean (beneath the snow), thus access to these sites is crucial. Access may be provided by downed and leaning logs, decayed stumps, and trees of large diameter (Clark and Campbell 1977, Hargis and McCullough 1984, Steventon and Major 1982). Spencer et al (1983) illustrate a preference for foraging in sites typified by large volumes of coarse woody debris, and numerous stumps and snags (figure 1).

Marten require well insulated resting dens when not active. This is because of the energy inefficiency of their long thin body shape, lack of fat reserves and relatively poor insulation (Brown and Lasiewski 1972, Buskirk et al 1988). Dens are almost always subnivean and typically associated with coarse woody debris such as squirrel middens, stumps, snags and the root masses of large trees (table 2). Females may have more restrictive requirements during the whelping period (March through August). At this time above ground dens may be necessary in order to protect kits from wet spring ground conditions (Wynne and Sherburne 1984).

Marten habitat use investigations demonstrate that marten prefer forests with 30 - 80% coniferous canopy cover and generally avoid areas with little or no canopy cover (Koehler et al 1975, Spencer et al 1983, Buskirk 1984). This may be a reflection of their need for both security and thermal cover, or may be a function of the type of forest suitable for foraging and denning. This behaviour is most pronounced with females.

MANAGEMENT RECOMMENDATIONS

Management Objectives for Marten

In general provincial management objectives for marten are first to ensure locally sustainable, viable populations and secondly to ensure populations that produce harvestable surpluses in areas that are trapped.

The amount of winter habitat required will depend on population objectives for a given planning area (TSA, Trapline, etc.). This could vary substantially from area to

Table 1 Food Habits of Marten.

Source	Small Mammals (voles, shrews, mice)	Larger Mammals	Ungulates	Birds	Fish	Reptiles Amphibians	Invertebrates	Plant Parts (vegetation and fruit)
Buskirk & MacDonald (1984) (% volume of scat and colon contents)	71.0	13.2	2.3	4.9	0.4	-	-	5.7
Cowan & McKay (1950) (% of food in scats and stomach contents)	66.3	14.4	0.3	4.3	-	-	5.2	5.5
Francis & Stephenson (1972) (% of items in scats)	30.6-60.4	1.4-19.3	0-3.1	4.6-20.4	-	0-2.0	3.0-11.7	0-41.9
Hargis & McCullough (1984) (% volume of scats)	10-49	32-55	<1	4-7	0-1	-	<1	7-11
Lensink et al (1955) (% of items in scats and digestive tracts)	73.0	<1	<1	10.0	-	-	-	17.0
Slough et al (1989) (% frequency in scats)	77.9	16.4	0.7	10.7	-	-	4.4	16.8
Zielinski et al (1983) (% volume of scats)	35.0	39.6	1.2	5.3	0.1	-	2.9	2.0

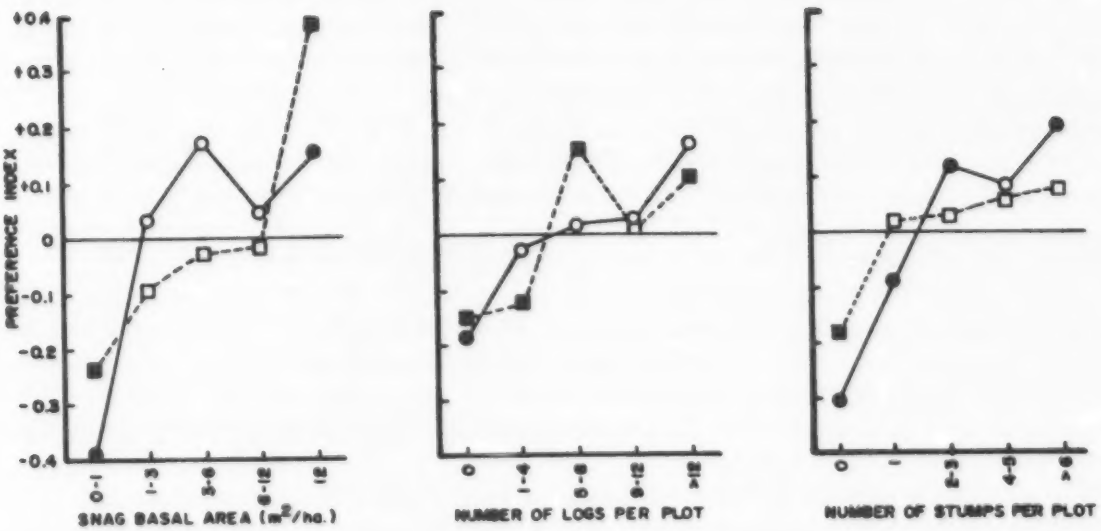

Figure 1. Marten preferences for snag basal area, log density, and stump density (from Spencer et al 1983).

Table 2 Characteristics of Marten Winter Resting Sites.

Source	Location	Type	Number
Buskirk (1984)	Alaska	Squirrel Middens	26
		Other Ground Burrows	6
		Squirrel Nests in trees	3
Buskirk et al (1989)	Wyoming	Large Woody Debris	28
		Rock Piles	11
		Above Snow (warmer days only)	11
Marshall (1951)	Idaho	Hollow logs and stumps	16
Mech and Rogers (1977)	Minnesota	Ground Burrows, Rock Piles	12
		Tree Canopy	1
Raine (1981)	Manitoba	Squirrel Middens	3
Spencer (1987)	California	Cavities in Decayed wood	55
		Log Pile	8
		Rock Pile	5
		Willow Clump	1
Steventon and Major (1982)	Maine	Decayed Wood and Hummocks	26
		Base of Snags	2
		Debris Piles	3
		Tree Canopy (warm weather)	1

area depending on management objectives.

The lowest densities reported in the literature for self-sustaining populations are around 0.4 resident animals/km^2 over extensive areas (Soutiere 1979). Managing for minimum populations may, however, mean minimal or no opportunity for fur harvest. High quality habitat may support densities as high as 2/km^2 (Soutiere 1979, Thompson 1988).

TIMBER HARVEST STRATEGIES

Selective or Partial Cut

Where feasible, partial or selective cutting systems can effectively maintain marten habitat values, and from the perspective of marten habitat management are preferred. In Spruce/Fir forests of Maine, Soutiere (1979) reported virtually unchanged densities of 2.08 marten/km^2 after a diameter limit cut that reduced basal areas by 40% leaving residual stands of 20-25 m^2/ha. (basal area). In the Sierra Nevada Mountains of California, Spencer et al (1983) found marten selected for stands where basal area was about 40 m^2/ha and suggested selective cutting systems that leave 40-50% of the canopy. Clark and Campbell (1979), in Wyoming, suggested that leaving at least 40% of the trees didn't alter conditions enough to influence the preferred small mammal foods of martens.

We suggest that an interim guideline for selective harvest in marten habitat should leave about 50% of the basal area or a minimum of 20 m^2/ha basal area; should maintain a minimum 30% canopy closure, and sufficient coarse woody debris. Provision of coarse woody debris is discussed below.

Even-Aged Management (Clear-cutting Systems)

Landscape management refers to the interspersion of suitable habitat for marten over time and space (Bissonnette et al 1989). Marten habitat studies (Clark and Campbell 1977, Soutiere 1979, Snyder and Bissonette 1987, Thompson 1986) have shown this species does not significantly utilize clear-cuts for some considerable period of time (15-40 years cited). Thus, the impact of clear cutting on populations can be considered a function of the extent and distribution of timber harvest.

How quickly, and to what extent, clear-cuts recover as suitable habitat is dependent on ecological site conditions and, most importantly, on silvicultural treatments applied. Thompson (1988) reported for boreal forests in central Ontario that marten densities were reduced by 67-90% in extensively logged areas for up to 40 years. Soutiere (1979), in Spruce/fir forest of northern Maine, reported that an area with 50% clear-cuts and 25% selectively cut forest had 1/3 the density of marten found in adjacent uncut or diameter limit cut areas (figure 2). It is interesting to note that some wildfires seem to quickly return to productive marten habitat in spite of the loss of most standing timber (Magoun and Vernam 1986, Slough 1989). This is possibly a result of their being typified by large amounts of coarse woody debris and patches of

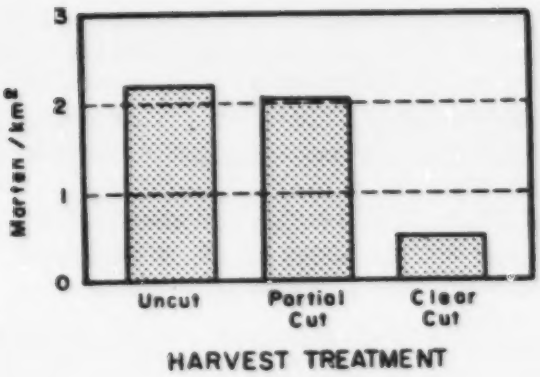

Figure 2. Marten density as a function of timber harvest treatment (from Soutiere 1979).

unburned trees.

To maintain the recommended minimum population levels (0.4 residents/km^2) no less than 50% of an area should remain as suitable marten winter habitat. Further, uncut areas should be a minimum of 25 ha. in size (Bissonette et al, 1989). As marten seldom venture more than 100 metres into openings (Hargis and McCullough 1984, Ingram 1973, Simon 1980, Spencer et al 1983) we recommend that uncut areas be no further than 100 meters from adjacent suitable patches of habitat. These patches should not be removed until the cut areas have returned to suitable habitat conditions.

Trapline management may involve the establishment of untrapped population refuge areas as part of the registered trapline. These refuges, or portions of them, should be considered as candidates for leave areas when developing harvesting plans.

SILVICULTURAL CONSIDERATIONS

Minimizing the length of time for cut-overs to return to productive marten habitat will also minimize the delay before first pass residuals can be cut. Essentially the goal is to re-construct or mimic the structural features of mature or "old growth" forest that are key to marten use. Silvicultural activities can greatly influence this.

Providing for marten habitat in forestry operations should begin with the layout and harvesting stages. Snags, logs, and stumps should be left within clearcuts, either scattered or in clumps. These features (referred to as Coarse Woody Debris - CWD) function as marten foraging and denning sites. Spencer et al (1983) reported preferences for areas with 125-200 logs/ha., snags at a stocking of 3-6 m^2 basal area/ha. and 50-75 stumps/ha.. Our interim recommendation is to retain average CWD volumes of 100 m^3/ha of logs > 20 cm. in diameter (based on Spencer et al 1983, Buskirk et al 1989, Lofroth, unpub. data) and 5 m^2/ha basal area of snags (Spencer et al 1983). Snags may be of particular importance as maternal dens (Wynne and Sherburne 1984).

Site preparation should avoid creating "clean" sites devoid of CWD. Practices such as windrowing and burning, stump removal, or high intensity broadcast burning are detrimental. Maser et al (1979) illustrate how careful planning of site treatment can reduce impacts on availablity of woody debris.

It is clearly of advantage to try and save the largest diameter CWD as they are the most valuable to marten, have the longest life span, and can be most easily saved during site treatments such as burning. Buskirk et al (1989) found that of those dens associated with coarse woody debris, the majority were in forest types with larger diameter (mean = 0.27 m) logs on the forest floor. Spencer et al (1983) noted that the soft bases of large, dead fir trees offered the ideal winter resting sites. Where debris must be removed, leaving piles unburned is preferred and may create hunting or denning sites (Steventon and Major 1982)

In managing for CWD it must be recognized that snags, logs, stumps, etc. have limited life spans and eventually decay and disappear. Material with some rot is best for dens, but it is important that a significant portion of the CWD retained in cut areas

be sound so as to maximize the lifespan of its utility to marten. It is also imperative that provision be made for the creation of replacements through successive forest rotations.

Stand tending also impacts habitat recovery through vegetation structure and composition. Providing adequate amounts of coarse woody debris have been maintained, the site will again become suitable marten habitat at about the "young forest" stage of development (Hamilton 1987). This is characterized by a canopy beginning to differentiate into distinct layers and the initiation of stand self thinning. This usually begins about age 30 years. This process may actually be accelerated by thinning in the pole/sapling stage. Excessive brushing and weeding may reduce prey populations in early stages of marten use or reduce berry availablity of summer/fall periods when clear-cut use has been reported (Steventon and Major 1982).

It is important to recognize that our recommendations are based on information from studies conducted in many parts of North America. Although the literature on marten and logging relationships is consistent, they are offered as interim guidelines until refinement is available from studies conducted specific to interior forests of B.C. There is a need to develop habitat assessment and planning tools to aid in refinement and implementation of guidelines. Another important step will be to apply these guidelines operationally and test their effectiveness in a variety of situations.

We want to emphasize that the above recommendations are a "worst case scenario", designed to provide habitat for a minimum self sustaining population of marten over an extensive area. Management of habitat for populations with harvestable surpluses may require more conservative guidelines.

Marten may not be the sole beneficiary of improved habitat management. There are many other species of wildlife (particularily cavity nesting birds and small mammals) that depend on snags, logs and stumps and a component of forest cover for at least part of their life.

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RELATIONSHIPS BETWEEN TIMBER MANAGEMENT AND GRIZZLY BEARS

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ABSTRACT

Three important ways forest management can affect grizzly bear (Ursus arctos) populations include: 1) displacement, 2) habitat alteration, and 3) increasing mortality rates directly or indirectly by improving access for hunters, poachers, other resource users, and settlers. Grizzly bears are able to adapt to many habitat changes and a temporary increase of human presence. In most cases, improved access resulting in increased human activity and/or settlement and consequent increase in bear mortality is the most significant aspect of timber management. For long term maintenance of grizzly bear populations, large areas should be delineated that do not necessarily exclude timber management, but have strict control of access and no permanent human settlement.

INTRODUCTION

Grizzly bears are no longer found in much of their historic range. Even in British Columbia, which is blessed with innumerable rugged mountains and inhospitable valleys, the range and number of grizzlies has been reduced. Although National and Provincial Parks preserve some habitat, parks were often established where scenery was exceptional; enormous rock massifs, ice-fields, and open alpine landscapes are breathtaking but poor for bears. Additionally, even the largest parks are small when compared to the movements of a population of grizzlies.

There is concern that as people develop remaining grizzly habitat, reductions in bear range and numbers will continue. In the lower 48 states, an estimated 1% of the historic number of grizzlies are found in about 1% of their historic range. Almost all of the remaining grizzly bears are in two remnant populations centered in large National Park and Wilderness Area complexes. They are managed intensively, at times on an individual basis, at a cost of more than two million dollars annually. Could this be the future for grizzly bears in British Columbia?

Forestry is the dominant industry in most of the remaining grizzly habitat in British Columbia. If we can maintain healthy grizzly bear populations in managed landscapes their future is bright. If we cannot, their future is bleak. In this paper I examine the 3 major ways that timber management can affect bear populations: 1) displacement from areas of human use, resulting in the loss of habitats available, 2) altering the dynamics of plant and animal communities, or habitats, that bears live and depend on, and 3) causing an increase in the number of bears killed by people. These avenues of influence represent the three submodels of the cumulative effects

models used in the U.S.A. to predict grizzly bear population responses to human activities (Weaver et al. 1986). Many of the ideas and data summarized in this paper were previously presented by McLellan (1990).

DISPLACEMENT

When a bear encounters a person or a vehicle it usually runs to cover (McLellan and Shackleton 1989 a). Such encounters, however, are rare. Humans are relatively predictable; being almost always on roads, at a settlement or job site. Bears simply avoid these locations by enough distance so they are not disturbed by a passing vehicle or a faller starting a saw (Tracy 1977, Harding and Nagy 1980, Aune et al. 1984, Archibald et al. 1987, Mattson et al. 1987, McLellan and Shackleton 1988, 1989 b). Some variables that interact to determine displacement distance of an individual bear include the individual's past experiences, age/sex class, amount of cover, density of bears in the area, and relative quality of resources near and far from the human activity center.

Grizzly bears are capable of habituating to human activities provided the activities are frequent and innocuous, such as hikers on heavily used trails or vehicles on roads (Jope 1985, McLellan and Shackleton 1989 b). Displacement distances from newly established human activity centers should decrease with time until they reach a minimal threshold (Singer and Beatte 1986). Visual cover appears to affect the bear's sense of security and displacement will be reduced when cover is present. Managers can retain cover to enable bears to use quality habitats near roads or remove cover to increase displacement around camps. Visual cover is not limited to vegetation. Darkness also provides security cover and bears use areas near or on roads and campgrounds more at night than day (Nadeau 1987, McLellan and Shackleton 1988). The ability of cover to reduce displacement is the basis for many basic habitat management prescriptions (Blanchard 1983, Zager et al. 1983, Young and Beecham 1986).

The relative quality of habitats near to and far from human activity areas and how limiting these habitats are may also influence displacement. In an area where the bear population is below carrying capacity or during a season of plentiful foods, most bears will be far from human use areas because little would be gained by moving close. If, however, the bear population is at carrying capacity, thus creating competition for limited seasonal resources, there would be a benefit in moving closer to areas of high human use. When the best foraging sites are close to human activity centers, such as garbage dumps or roadsides seeded to grass and clover, many bears are attracted.

Female grizzlies with young are most often found where adult males rarely go. Pearson (1975) and Russell et al. (1979) found female grizzly bears with young segregated from adult males by elevation. In other study areas, age-sex classes may segregate by distance from human use areas. In the Yellowstone Ecosystem and the Flathead adult males used areas far from roads while adult females with cubs and some younger bears used areas near roads and developments more frequently

(Mattson et al. 1987, McLellan and Shackleton 1988).

Due to many variables influencing displacement, we expect and find variation among study areas. Most studies have reported minor displacement from industrial sites (Simpson et al. 1985, McLellan and Shackleton 1989 b, Archibald et al. 1987, Schoen and Beier 1988) while Mace and Jonkel (1980) found radio collared bears to avoid a drainage while logging was in progress.

Reductions in grizzly bear day time use of areas within 250 m of roads in the Flathead and up to 500 m in Yellowstone Park have resulted in habitat loss equivalences of 8.7% and 15.7% respectively (McLellan and Shackleton 1988, Mattson et al. 1987). Because bears can not use all areas at the same time, shifting use towards roads at night and disproportionate use by security-conscious individuals would reduce actual habitat loss equivalence.

ALTERED HABITATS

Timber management alters the populations of plants and animals as well as physical characteristics that together make bear habitat. Through plant succession, further habitat change occurs for many years. Industrial habitat alterations may harm or benefit bear populations during various periods of succession (Lindzey et al. 1986, Brody and Stone, 1987).

Of variables determining the effect of habitat alterations, the quantity, quality and duration of bear foods produced are most important. Removing food producing trees such as white-bark pine (Pinus albicaulis) will likely have a negative impact on bears whereas removing other species of trees could have a positive impact by increasing the production of foods like berries (Martin 1983, Zager et al. 1983, Bratkovich 1986), grasses and horsetails (Equisetum spp.) (Zager et al. 1983, Young and Beecham 1986, Bratkovich 1986, Simpson 1987), or ungulates (Thomas et al. 1979) for varying lengths of time.

To be of added value to the bear population, the production of bear food in the cut block must not only increase but increase to where it is used. If the bears are below carrying capacity, food production in cutting units may have to be the best in the area before being used. If the bear population is at or near carrying capacity, subadults or security conscious females with cubs may use less productive sites (Pearson 1975, Russell et al. 1979, McLellan and Shackleton 1988), and more use of cutting units would therefore be observed. Timber harvest used as a habitat enhancement tool is valuable only if it produces a bear food that is of limited supply elsewhere in the bears' ranges.

Because crown closure and lack of woody debris in second growth conifer stands may reduce food production for most of the timber rotation, timber management practices have a long term effect on bear habitat that must be taken into account. It is possible that in some areas, a long term forest management plan could ensure a varied forest age structure with at least some sites producing bear foods at any given time during the timber rotation.

The proximity of security cover is also an important variable influencing use of a

cutting unit. Given equal foraging opportunities in cover and in the open, bears will feed in cover. The distance from cover that bears will go to forage is likely an interaction between how much better the foraging opportunities are in the open (benefit) and the amount of human activity in the area (risk).

The general lack of documented use of clear-cuts by bears (Zager et al. 1983, Young and Beecham 1986, Schoen and Beier 1988, McLellan 1989) even though bear food production often increases after logging (Martin 1983, Zager et al. 1983, Bratkovich 1986) is likely because: 1) the clear-cuts still did not become better foraging sites than other habitats, 2) there are usually open roads entering clear-cuts, and 3) these bear populations may be below carrying-capacity due to historically heavy hunting and therefore, security conscious individuals are not displaced into suboptimal foraging areas.

Because grizzly bears are found in very diverse ecological zones, general conclusions regarding the quantity, quality and duration of bear food production in logged and treated sites are not possible. General prescriptions or recommendations, therefore, are not only difficult but perhaps dangerous. For example, based on research in the Flathead drainage in Montana, Zager and Jonkel (1983) recommended minimal scarification after logging to reduce impact on shrub rhizomes. Less than 100 km north of their study area, most grizzly bear feeding in cutting units is for Hedysarum sulphurescens which grows abundantly in scarified units (McLellan, unpubl. data). Recommendations should be based on ecological knowledge for specific habitat types and preferably specific sites.

Input from biologists on forest management plans in bear habitat is often directed at ungulates or fisheries. However, reducing cutting unit size, creating irregular edges, leaving cover between cutting units and roads, and protecting snowchutes for cervids and riparian habitats for cervids and fish has greatly reduced the impact of timber harvest on bear habitat as well.

Throughout most of their range grizzly bears rely heavily on berries. Because these usually grow best in areas burned by wildfires, fire suppression will have an enormous effect on grizzly bears. Burns at high elevations, where trees grow slowly and are often inaccessible, are good berry producers. Prescribed fires or a "let burn" policy in these locations will eventually be required to maintain current grizzly populations.

DIRECT MORTALITY AND ACCESS

Within the last century grizzly bears were intentionally eradicated from a large portion of their range by the ranching industry, leaving large tracts of suitable but vacant habitat (Brown 1985). Stories from the past of bears being shot in and near logging and mining camps are also common. Today, however, mortalities directly caused by industry are relatively rare. Of 73 known or suspected deaths of marked grizzly bears in British Columbia, Alberta, Montana, and Idaho study areas where resource industry occurs, none were directly due to resource extraction industries, except ranching (Table 1). Cattle were grazed in only 1 of these study areas and

Table 1. Number of Marked Bears Killed by Various Causes in Montana, British Columbia, and Alberta Study Areas with Industrial Resource Activities (from McLellan in press).

Study	Industries[1]	Number Marked	Years Record	Mortality Factors: Hunt	Illegal	Livestk Depred.	Industry	Problem	Natural	Research	Total
McLellan (unpublished)	OT	85	12	9	8	0	0	2	2	1	22
Simpson (pers. comm.)	TH	13	5	2	2	0	0	0	2	0	6
Hamilton (pers. comm.)	T	21	6	2[2]	0	0	0	1	2	1	6
Aune & Brannon 1987	OL	40	11	7	4	4	0	0	1	1	17
Nagy et al. 1988	OT	38	5	11	0	0	0	0	2	5	18
Knick and Kasworm 1989	TM	19	5	0[2]	4	0	0	0	0	0	4
Total —		216	44	31	18	4	0	3	9	8	73
Proportion				0.42	0.25	0.05	0.0	0.04	0.12	0.11	1.00

[1] T = timber; O = oil and gas; H = Hydroelectric; L = Livestock; M = Mining

[2] Hunting was closed in this study area

there the most common cause of grizzly mortality after legal harvest was control killing due to livestock depredation (24%; Aune and Brannon 1987).

The forest industry requires a network of roads to extract and manage timber. Once roads are built, improved access may make other industries economically viable, settlement more practical, recreation more available, and consequently, there is usually great increase in human use. The amount and predictable pattern of vehicular use by industrial personnel and others may reduce displacement of grizzlies due to habituation, but this makes them more susceptible to being shot. Attracting bears to productive cutting units, or seeding landings and roadsides with grasses and clover while leaving road access intact, can also make bears vulnerable to hunters and poachers and to collisions with vehicles (Simpson 1987). Of the 73 mortalities of marked grizzlies in the previously mentioned studies, 42% were due to legal harvest, and 25% due to illegal harvest, whereas only 12% were natural. These bears did not all have active radio-collars when killed, and consequently there are biases in these data. Because of compulsory reporting, all legally killed bears were likely recorded whereas there were probably more illegally killed bears with both functional and nonfunctional radios than reported. In 3 of the 6 studies, there were as many or more illegal than legal mortalities.

If wildlife managers consider the mortality rate of bears to be excessive, they can relatively easily reduce the number of legal kills. Once an area is accessed to where illegal and control killing alone are excessive, it becomes extremely difficult and expensive to reduce the number of human induced mortalities.

RECOMMENDATIONS

Habitat management for grizzly bears involves protection of components such as skunk cabbage, riparian and snowchute complexes either by preserving them, or perhaps by prescribing uneven age timber management practices. Removing conifers by timber harvest or fire can be used in other locations to promote early seral species such as forbs and grasses, berries and some ungulates. The timing and spacing of cuts is important to ensure that security cover is maintained between foraging sites.

Although habitat management is very important, road construction in remote areas appears to be the major long term impact of timber harvest on grizzly bears in most locations. Open roads influence all three ways that people affect bears; they displace bears from quality habitats, they cause bears to use cutting units and other open habitats less often, and they permit access for many people. All of these people help habituate bears. Many people condition bears by leaving, partially burning or burying foods. A few people will shoot bears. Grizzlies reproduce so slowly that a population can tolerate relatively little mortality.

The maintenance of a healthy grizzly bear population in a managed landscape will require proper habitat management together with access management that may include reducing existing access in order to regain wilderness. These plans will be unpopular with some administrators and citizens who want to continue to "settle the west". Agencies, industry, and other user groups must co-operate in educating the

public and advertise the value of long term access plans.

To ensure the long term existence of Canadian grizzly bears we should buffer existing parks and reserves with areas that would permit timber management but have strict access management. This would increase the size and variability of reserves to where they may be effective in preserving grizzlies and other large carnivores during periodic climate changes and local catastrophes.

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LUNCHEON SPEECH

INTEGRATED MANAGEMENT

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Thank you for the opportunity to come here and take part in your symposium on integrated management.

I wondered as I thought about this issue, has anything changed to make this symposium or this discussion any different than the number of others we have had over the past 15 years on attempting to integrate the concerns of fish and wildlife and other non-timber resources with timber harvesting? The usual process is to have a series of speakers identify what the current state-of-the-art is with respect to the habitat requirements of various species, then someone else outlines the way the system should work in a perfect world and then we all go back to the real world and try to make a silk purse out of a sow's ear, many of us without even the luxury of starting with a silk pig.

In the cold hard light of day, has anything really changed to indicate that things should be any different and any better than in the past? And if by the past we mean the last five or six years, it has been my impression that integrated management has degenerated from a state in the late seventies where it was at least alive and kicking in many parts of the province to where it is only a poor shadow of the process it was intended to be.

True, there are positive examples, but they tend to exist largely due to the efforts of individuals and personalities rather than institutional commitment.

Without that commitment, all the symposiums and good intentions will do nothing more than let us leave here with a warm glow, that for Fish and Wildlife staff should carry them through to, I'd say, about Friday morning at 8:45.

Enough of this pessimism!

The 1990's are supposedly to be the decade of the environment and whether you, like many others, have undergone a real conversion and have been "born again", or are simply using the present environmental interest as another "flag of convenience", we should look at the start of this decade as a slate wiped clean, with an opportunity to start all over again. I think that the 90's will see a commitment by government and industry to put the necessary number of staff in the field to make integrated management a potential success.

What have the lessons of the past 15 years told us if we are to make a success of integrating the most valuable forest resource in the world with the most abundant and diverse fish and wildlife resources in North America?

I want to share with you some of my perceptions of what we have to do differently.

1. We should avoid being completely absorbed and consumed by the currently trendy phraseology of the day, without a clear understanding of what it means.

I can remember in the 70's how every problem we had was going to be solved by "multiple use", later by "coordinated land use planning", still later by "integrated management".

We face the same thing now with 'sustainable development". Every time you turn on the news, some group or other is suggesting this concept will be the Messiah we are all awaiting, and we are making the same old mistakes all over again.

I have heard it used as the justification for the old forestry policy of sustained yield, the mining industry's claim that it means every proposed mine will go forward, and the radical environmentalist claim that it means there will be no more clearcutting.

If we can't do anything else differently, let us at least accept a common set of definitions so that every side in the argument will know what we are talking about and how it applies to the interface between forestry and fish and wildlife.

Let's not confuse where are going with fluffy phrases that can mean all things to all people and in the final analysis, nothing to anyone.

So as we enter a new decade, let's be sure that when it comes to managing the forest and integrating the various forest values, that we are committed to the specifics of sustainable development:

- full cost accounting of any proposed development,
- an emphasizing of quality over quantity,
- reorienting and reviewing our concept of growth from what it is at present,
- conserving the diversity of resource base, not borrowing from the environmental capital,
- giving the environment as high a profile as the economy in any decision.

That's what sustainable development implies so let's be sure we all mean it, if we are going to say we accept the concept.

2. Let us avoid promising everyone everything, as integrated management seemed to do in the past. We especially heard this from spokesmen from industry in the past decade:

"You know all this confrontation is really non-productive, if we just practice integrated management (or multiple use, or sustained development) and especially if we just communicate better, we can have all these jobs and all this wildlife as well."

No, we can't.

We should stop telling people that. The public are not children.

There is a good mix of benefits that we can arrive at from improved integration that will satisfy a lot of the people of B.C., but not all of them.

I think most people would prefer to hear the absolute truth and be forced to make a hard choice, as opposed to being promised everything. If we want to maintain the diversity, abundance and distribution of wildlife that this province now enjoys to the exclusion of the rest of North America, then you in the industry will have to give up some wood.

Not only be better at communication, not only be more careful at logging, not only do better planning.

But give up some wood.

In some cases maybe not that much, in others maybe quite a bit, but all the integration and communication in the world won't change that fact.

Everybody can't have everything. Sustainable development is no more a "magic bullet" than were the other resource management concepts of the day.

A common statement is that we have ten years to make choices that we will have to live with for the next century and I believe this. But let's make certain that we concentrate our effort in providing the information necessary to make these informed choices and let's avoid pretending that hard choices are not necessary.

And that there is some process that we can now embrace that will preclude the necessity to make hard choices.

There isn't.

Speaking of hard choices, that leads me to my third point.

3. We have got to rapidly come to some consensus about those areas that will be designated for single use, because our reticence in designating such areas is confusing and confounding the successful implementation of integrated management.

You can divide this entire land use question into two issues.

1. What areas should be set aside for single use?
2. What area should be managed for integrated use?

We have to come to a stage in land use planning in this province where the two issues have to be separated.

We have to make a decision on how much land in what part of the province are we going to set aside for:

wilderness areas?
wildlife management areas?
ecological reserves?
agriculture land reserves?
parks?

We have to have a process so credible and a designation plan so liberal that the public organizations will buy into it and accept the plan.

Having done that, we will have, de facto, made the decision that the rest of the province will be used for a variety of compatible uses.

The arguments then become how much to log, where to log, rate of cut, etc., but these questions are resolvable by men and women of good will because they are not complicated by the first order question of whether an area gets developed or not.

Unless the public can see this sort of long range plan to designate some of the province, every issue will become the environmental equivalent of Cluster's last stand.

4. My fourth point is that while the companies have perhaps sometimes gone overboard and promised the public everything, the public has been equally unreasonable in putting forward a myriad of demands that Solomon couldn't satisfy, with the expectation that they have a right to have all of them accommodated.

There are many more actors in this whole question of integration than just the forest companies, the MOF, Fish and Wildlife and a few interested environmental groups.

There are the hunters, the fishermen, the naturalists, the heliskiers, the helihikers, the trail riders, the trappers, the antitrappers, the guides, the prospectors, etc., and over-shadowing the whole issue is the question of the rights of the native people in these areas.

And to complicate things further, the public is now concerned with the concept of the ecosystem as a whole, protecting values such as biodiversity, not just the individual, high profile species such as deer and moose.

I don't have any answer to sort this out. I must admit to personal disquiet to appointing a local advisory group every time there is a logging plan, but perhaps that is what the public wants. Again, I think he public would be content to let the managers manage it, if they thought there was a larger provincial plan in place that recognized all legitimate uses and set up some objectives for meeting the demand in each area.

I think the design of such a provincial strategy is the level at which the public should have most of its input, not in managing every cut block.

As long as we avoid this one large planning and priorization exercise, we will have to live with the public's lobbying and demand for input every time we go into a different watershed.

I don't have any ready-made answer for sorting out this mess.

The only absolute I can offer is that without keeping the land base in state of production, none of the activities will be possible, so the prime directive has to be maintaing the sustainability of the land and not foreclosing on future options.

A final challenge that could be the major hurdling block to implementing succesful integrtated mnagement is the question of "credibility".

I don't know if any of you have seen recent polls but the credibility of government and industry when it comes to environmental issues is at an all time low.

The participation and trust of the public in the whole process of integration is a key component, and why should they believe us?

The recent move to setting up regional and local land use boards is almost open admission that the process within government either has not worked, or is simply not credible as it presently exists.

The first job for all of us, government and industry, is to get back some credibility and show that integrated management can be compatible with preservation of the greatest biological diversity in North America out there on the ground, not just in a full page newspaper ad.

Bill Young in his talk referred to people such as myself, Ray Demarchi and John Cuthbert as "young Turks" who would still have to lead the charges.

Speaking for the three of us, and after 15 years in the environmental wars, I know my sword is dull, my shield badly dented, I've taken too many blows on the helmet and I think my horse is dying.

But at least I still have a sword, a shield, a helmet and a horse and even more important, I know there are all kinds of other people out there who are just as committed and just as adamant as we are that integrated management will work.

The environmental pressure that is now being applied by all sectors of society will mean that the 1990's will be a whole new ball game!!

It's our turn!!!

LUNCHEON SPEECH

INTEGRATED RESOURCE MANAGEMENT FROM A FORESTRY POINT OF VIEW

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INTRODUCTION

I appreciate this opportunity to speak at this excellent forum for the integration of wildlife and forest resources.

I would like to stress two themes. First, we are extremely fortunate in British Columbia in that we have many options available in resource management.

Second, as the demands on our resosurces grow, we will be challenged by hard choices and therefore we need to plan effectively for the future through a spirit of cooperaion and compromise.

We have excellent examples in British Columbia of how effective research and planning directly intended to integrate wildlife and forestry can and does work and I will mention some of these.

British Columbia is blessed with abundant natural resources that have shaped our economy, our culture, and our respect for the environment including our forest resources. We still have a lot of options open to us in how we use our natural resources.

From a global perspective, British Columbia is unique in several important ways. British Columbia's natural resources are primarily a public asset. Since 1867, successive provincial governments have refrained from alieniating title to forest lands. Rights to harvest timber have been largely conveyed without ownership rights to the land. Most timber, therefore, is harvested from public land under some form of contractual agreement. As a result, over 90 percent of British Columbia's forests are managed under public policies to promote conservation and renewal of timber and other forest resources including wildlife and their habitat requirements.

In addition, British Columbia has a relatively young history of resource development and we still have rich and diverse natural resources that we can all be proud of. For example, approximately 70% of our inventory is mature or overmature and a significant portion of the province is still unroaded and in a wilderness state. In addition, we still have abundant and diverse wildlife populations that are in many instances globally unique.

Also, unlike much of the world's population which is struggling to survive, British Columbia's resource based economy has provided us with a level of affluence that enables us to broaden our choices and therefore our options for resource use. British

Columbia's large size in relation to its relatively low population affords great opportunities for continued economic prosperity while maintaining our unique natural resource heritage.

On the other hand, British Columbia does not have a large tax base to support our infrastructure of schools, roads, hospitals, etc. Therefore, we are relatively more dependent on our resource-based industries.

Most jurisdictions in the world have, compared to British Columbia, very limited resource management options. Their forests or wildlife may have been already significantly denuded, may be largely privately owned, or may be needed to enable the current population to survive. We are indeed fortunate in British Columbia that we are not cornered, that we can in fact look at a broad array of options and alternatives that provide the best overall benefit to British Columbians. Our future is very much in our hands.

Although British Columbia is blessed with abundant natural resources, frequently a number of different resource values are present at the same site and not all uses can be made compatible. Also, as our population and relative affluence have grown, our demands on our resources have increased.

Therefore, as the many demands for our resources increase, not all of them can necessarily be met. The many options we have enjoyed in the past will be reduced in the future. It is, therefore, imperative that we recognize this; that we attempt to resolve conflicts amicably but also recognize that some conflicts are inevitable and a fair and open process is needed for their resolution.

COOPERATION AND COMPROMISE

Collectively we have a tremendous pool of talent, knowledge and energy to improve our public policy and process for resource mangement that balance the many needs of society.

It is important that the decision making process by fair and that we believe it be so, because then we will more likely be willing to live with proposals that impact differently on different interests.

A fair decision making process requires cooperation and commitment. Resource management is a big job which involves many different players. If we all pull together, it makes the job a lot easier and the result more useful and gratifying.

Effective communication amongst all resource interests is simply the best vehicle for resolving conflicts. This requires the ability to see each other's problems as real and legitimate, and to continue negotiating and seeking innovative solutions when the going gets tough.

In the Ministry of Forests we use our integrated resource management (IRM) planning process to identify, recognize and resolve conflicts. IRM is a process that provides for interagency review and public input. IRM is also a process which continues to evolve to meet the needs of our changing society.

We undertake resource management plans for Timber Supply Areas (TSAs). These plans provide numerous opportunities for other agencies and the public to get

involved. Although we feel this planning process has worked well, we recognize major refinements are needed and this is being actively addressed.

Plans are the primary vehicle of integrated management and it is imperative that the process is a fair one and that it address all relevant resource issues.

Integration of resource use is key for several reasons:

- integration is mandated by legislation in the Ministry of Forests Act;
- integration is demanded by the public;
- integration is expected by other agencies;
- land and resource issues are a big concern of government, and
- integration leads to optimal use of the resource.

With respect to resource issues, we recently asked Forest Service regional and district managers to tell us what public issues they saw facing them over the next 12 months, and what they considered the chances were of resolving those issues locally. The results of this straw poll were very surprising.

We discovered that there are upward of 350 existing issues out there and more waiting in the wings. While this number is itself impressive, what's even more surprising is that managers feel they will resolve not 25 percent, not 40 percent, but a full 85 percent of these issues. Even if these estimates were out by 10 or 15 percent, it is not the result that many people would expect.

Successful resolution of conflicts is not only possible, but it occurs frequently in British Columbia. We can take considerable and justifiable pride in the fact that we most commonly do cooperate and seek an honest compromise for all in resource management.

Nevertheless, as I mentioned, our IRM planning process can and will improve. We envision that our IRM plans will integrate non-timber resource values, not solely in terms of timber impact as at present, but in their own terms. The result will be plans which clearly show the presence of other resources and a mosaic of resource uses. Our new Resource Emphasis Area mapping will help accomplish this. This mapping will allow non-timber stakeholders to better recognize their presence and value, and to see the results of their inputs in clear products of IRM planning.

As I mentioned at the outset, we have excellent examples in British Columbia of how effective research and plannning directly intended to integrate wildlife and forestry can and does work. These efforts have most often occurred with the cooperation of industry and government agencies, like Forests and Environment. I would like to mention some of these now as they provide positive illustrations of how we can and do work cooperatively together. Here are some examples:

- In the Cariboo region, a selective harvesting approach has been developed for mule deer winter range in interior Douglas-fir forests.

- The Integrated Wildlife Intensive Forest Research Project (IWIFR) has developed silvicultural regimes that are designed to provide suitable habitat

for coastal black-tailed deer and Roosevelt elk.

- A wildlife habitat handbook is being developed for the southern interior.

- The cooperative coastal grizzly project is developing handbooks designed to integrate forestry and wildlife.

- A faller-selection approach has been developed for interior deer and cavity-nesting birds.

- A prescribed burning program in northeastern British Columbia designed to improve range conditions for wildlife.

I would also like to mention that these cooperative initiatives will increase in order to improve our abilities to integrate wildlife and forestry. In this regard, I am pleased that Dr. Bruce McLellan has joined our staff as the wildlife habitat ecologist here in Prince George at the Red Rock Research Station. He will be addressing the research needs for integrated wildlife/forestry in northern British Columbia.

CONCLUSION

We have been most fortunate here in B.C. due to the richness and diversity of our natural resources, and due to our relative affluence. We are not a people in despair searching to use all our resources as commodity products. We have a lot of options still open to us.

However, the demands on our resources are increasing and our resources are limited. We can't satisfy everyone everywhere. We have to realize that cooperation and compromise will be key ingredients of resource management in the 1990s. We have to listen to the legitimate concerns of others, and each of us will have to be willing to give up a little ourselves in order to achieve a balanced use of our resources for all British Columbians.

The integration of wildlife and forestry is a key indicator of how effectively we in fact do resource management. This symposium is extremely timely in order to move us into the challenges of this new and exciting decade. Let's make it work and just do it in a climate of cooperation and care for each other and the rich resources we have been blessed with.

PROTECTING PLANTATIONS AND STANDS FROM SMALL MAMMALS

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ABSTRACT

Young forest plantations are susceptible to feeding damage by snowshoe hares and several species of voles in the interior of British Columbia. Monitoring population fluctuations of these species and identifying those forest areas which are susceptible to damage are two basic requirements for plantation protection. Flexibility in time of planting, tree species selection, and perhaps repellents will help reduce damage. Feeding damage by red squirrels occurs in managed stands of juvenile lodgepole pine. This damage may be reduced by provision of alternative foods or silvicultural design of stands. Both techniques achieve protection from squirrels and may enhance wildlife habitat use and species diversity.

INTRODUCTION

In general, small mammals serve as a vital food source for furbearers and various birds of prey such as hawks and owls (Fig. 1). Some species such as the insectivorous shrews (Sorex spp.) and bats (Myotis spp.) and omnivorous deer mice (Peromyscus maniculatus) and chipmunks (Eutamias spp.) feed upon insects and related terrestrial invertebrates. In this latter regard, these mammals may economically benefit an ecosystem by controlling some forest insect pests (Buckner 1966; Golley et al. 1974). In addition, several species, by consumption of fungi, distribute fungal spores which are essential for the vigorous growth of new coniferous forests (Maser et al. 1978).

On the other hand, some small mammals are also well known for their dietary dependence on the plant products (e.g. seeds, fruits, vegetative parts) of deciduous and coniferous trees, as well as agricultural crops (Fig. 1). It is when the feeding activities of these animals interfere with regeneration and intensive silviculture of new forests that they become classed as "pests". Feeding damage by small mammals occurs in three categories: (1) consumption of conifer seed (deer mice and chipmunks); (2) clipping and de-barking of young tree seedlings; and (3) de-barking and girdling of sapling trees. The attack of seedlings is done primarily by the snowshoe hare (Lepus americanus) and various species of voles (Microtus spp., Clethrionomys spp.) and lemmings (Lemmus sibiricus). Sapling trees are attacked by the snowshoe hare, red squirrel(Tamiasciurus hudsonicus), porcupine (Erethizon dorsatum), and various voles and lemmings.

The majority of feeding damage occurs during the overwinter period when preferred alternative foods are unavailable. In general, outbreaks of damage tend to

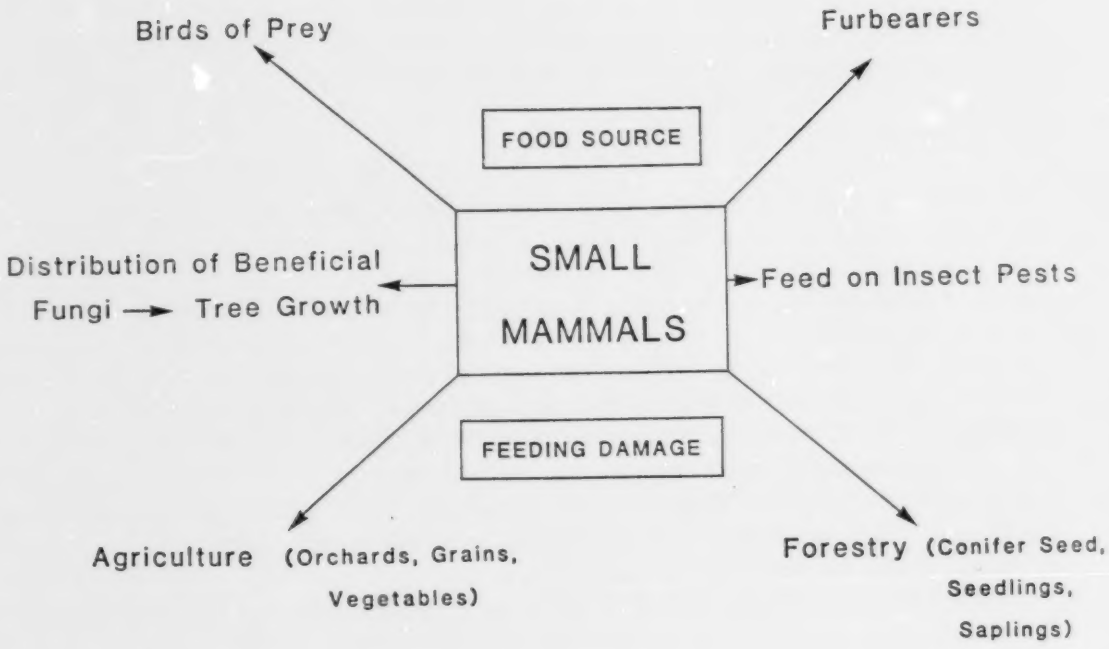

Figure 1. Interrelationships of small mammals as food sources for furbearers and birds of prey, positive effects from feeding on some insect pests and distributing beneficial fungi for tree growth, and negative effects from feeding damage to forest and agricultural crops.

occur in association with high populations of a given mammal species. It is during these peak populations that the majority of damage occurs in areas of reforestation. In other situations, favourable habitat for a given mammal species may arise from certain combinations of logging, site preparation, and planting practices; or from unsuccessful management (e.g. backlog sites). In these cases, such habitats encourage population increases in certain mammal species and consequent damage to regeneration efforts.

This paper will: (1) briefly describe the population biology and feeding damage caused by snowshoe hares, voles, and red squirrels; (2) outline the historical approach (use of toxicants) to this problem; and (3) discuss two methods using integrated management to reduce damage by the red squirrel.

SMALL MAMMALS AND PLANTATIONS

Damage to coniferous plantations by snowshoe hares and voles has been reported in many interior areas of B.C. Hares damage seedlings by clipping the leader and lateral shoots. Voles and lemmings also clip shoots of seedlings as well as debark and girdle stems and roots. A characteristic feature of the snowshoe hare is the 9- to 10-year cyclic fluctuation in abundance (Fig. 2). This cycling behaviour occurs throughout much of Canada but exhibits its most dramatic changes in numbers of hares in central and northern regions of its range. During peak years of abundance, hares severely browse seedlings in plantations during winter months when their alternative preferred foods (various deciduous plant species) are scarce. The historical record of cyclic fluctuations in snowshoe hares goes back at least 200 years. Feeding damage is usually most severe in those areas with sufficient cover to provide suitable habitat for residency of hares.

Most species of Microtus have a 2-5 year cyclic fluctuation in abundance (Fig. 3). Seedlings associated with grass habitats and those areas with a heavy shrub and/or post-harvest slash cover are particularly vulnerable to vole attack. Such habitats are preferred by voles and result in population buildups and consequent damage to seedlings.

Feeding damage by these rodents may result in direct mortality from girdling and clipping of tree stems or reduced growth (and yield) from sub-lethal attacks. Incidence of damage to lodgepole pine (Pinus contorta) seedlings, in particular, may be as high as 70% to 80% in susceptible plantations. In general, plantations on sites with good broadcast burns or low levels of post-harvest debris have a lower incidence of damage than those with high levels of logging debris. However, certain plantations even following broadcast burning as a means of site preparation still have high levels of rodent damage.

RED SQUIRREL AND YOUNG STANDS

The red squirrel may seriously damage crop trees in managed stands of lodgepole pine. Squirrels strip bark from a stem to feed on the cambium and exposed

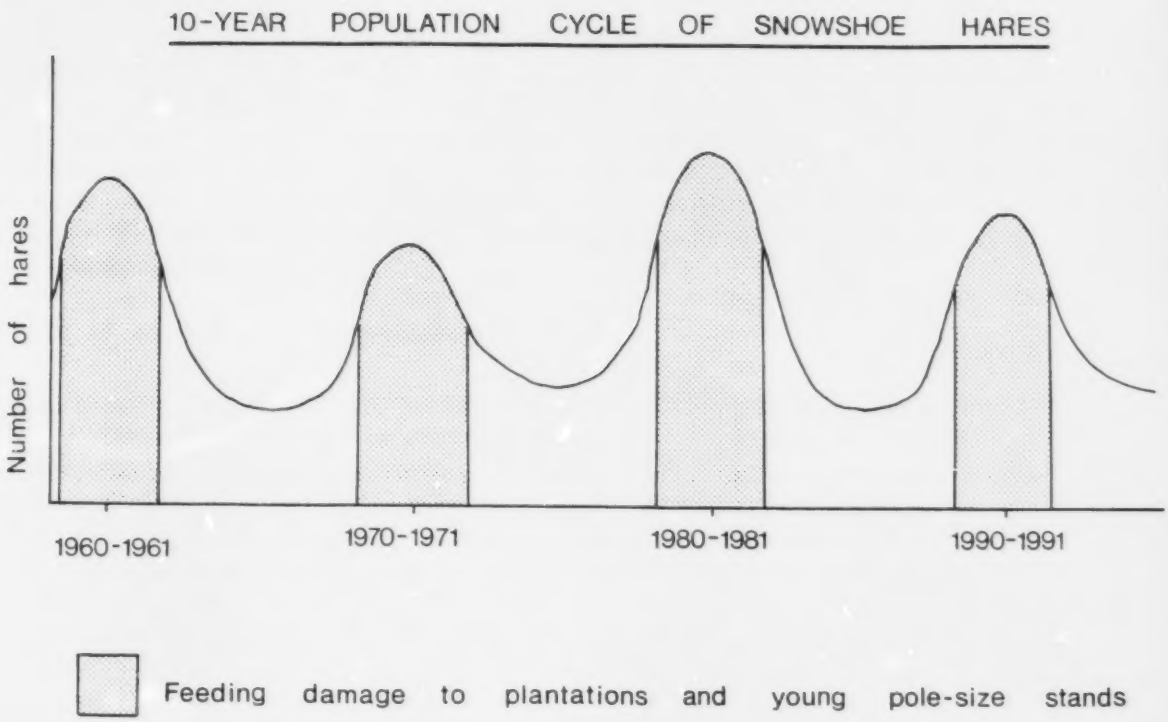

Figure 2. Conceptual model of the ten-year population cycle of snowshoe hares in boreal and sub-boreal forests of B.C.

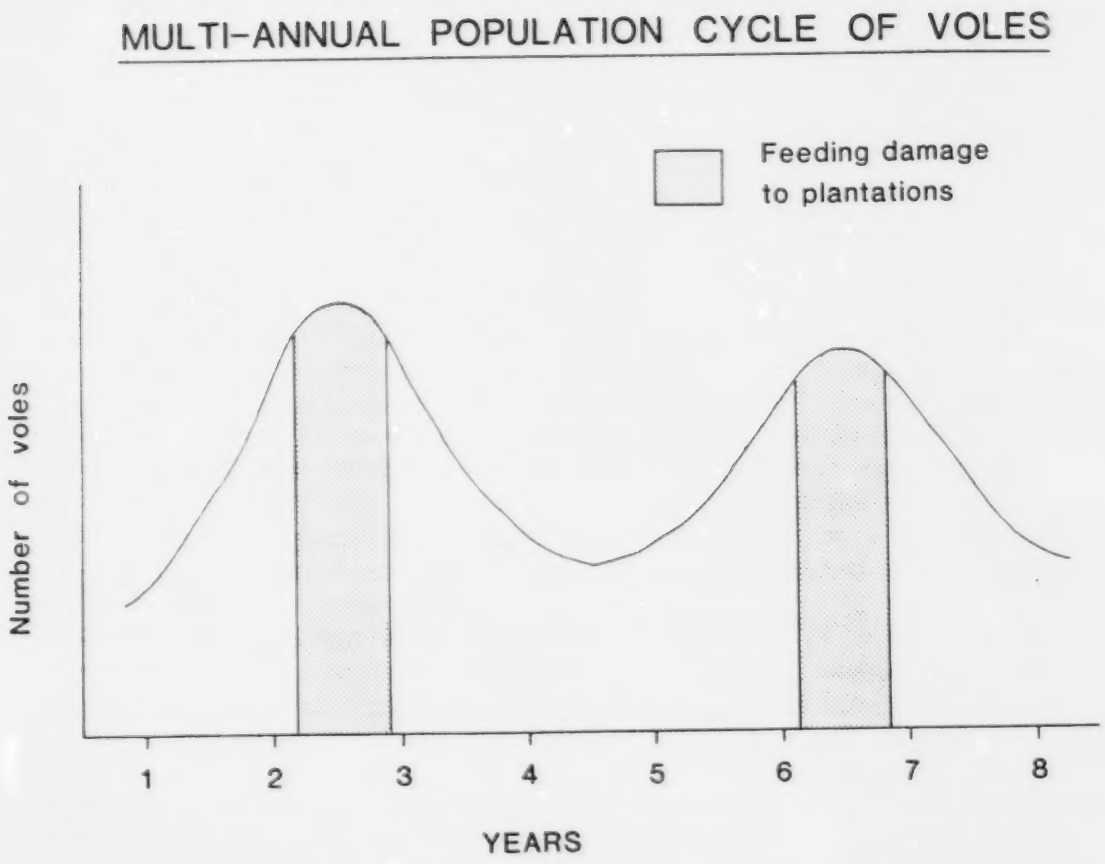

Figure 3. Conceptual model of the multi-annual population cycle of voles.

sapwood. Identifying characteristics of squirrel barking are the indistinct toothmarks on the sapwood and the presence of bark strips (3 x 8 cm) which accumulate on the ground under the injured tree. These bark strips are often the only evidence which distinguishes squirrel work from similar crown girdling injuries by the porcupine. Squirrels can damage any part of a tree because of their climbing ability whereas hares are restricted by snow depth. Most damage by squirrels occurs in the spring and early summer (May and June), during the early part of the growing season. Damaged stems are usually > 6.0 cm dbh.

Squirrel population fluctuations tend to coincide with cone crops (Halvorson 1984; Sullivan 1987). Squirrel abundance in a mature stand peaks in the year after a substantial cone crop, with a surplus of squirrels appearing in juvenile stands in subsequent years. Incidence of damage and feeding intensity generally tend to be associated with high densities of squirrels, although local exceptions to this pattern may occur (Sullivan 1987).

HISTORICAL APPROACH TO MANAGEMENT

The main method of protecting forest crops from small mammals usually involves the use of poison bait to reduce or eliminate the pest population. Poison or other lethal techniques may provide temporary protection and, in many cases, are the only methods available. However, the resiliency of rodents and lagomorphs to depopulation, poor bait acceptance, increased resistance to bait formulations, and the hazard to non-target species must all be given serious consideration when using poison bait for population reduction. The most significant factor limiting the long-term control of small mammal pests is resiliency. This term was originally defined by Holling (1973) as the ability of a system (e.g. population) to absorb change (e.g. reduction in numbers) and still persist.

The use of toxicants to reduce vole and hare populations is often considered a viable means of control. However, the resiliency of vole and hare populations during peak periods makes depopulation a futile exercise (Sullivan 1986). The example illustrated in Fig. 4 shows the response of snowshoe hares to depopulation over a 2-year period (Sullivan and Sullivan 1986). There was clearly a surplus of hares which provided a continual flow of animals into the removal area. At least on a local scale, depopulation by whatever method cannot keep pace with the surplus of animals during the critical damage periods.

Intensive studies of the population dynamics of small mammal species, with appropriate measurements of their resiliency to depopulation, will indicate the limitations of conventional control techniques for crop protection, at least on a local scale. An alternative approach advocates integrated management using provision of alternative foods and silvicultural habitat design.

RED SQUIRREL AND ALTERNATIVE FOODS

A particularly significant outbreak of squirrel damage has occurred in a fertilized

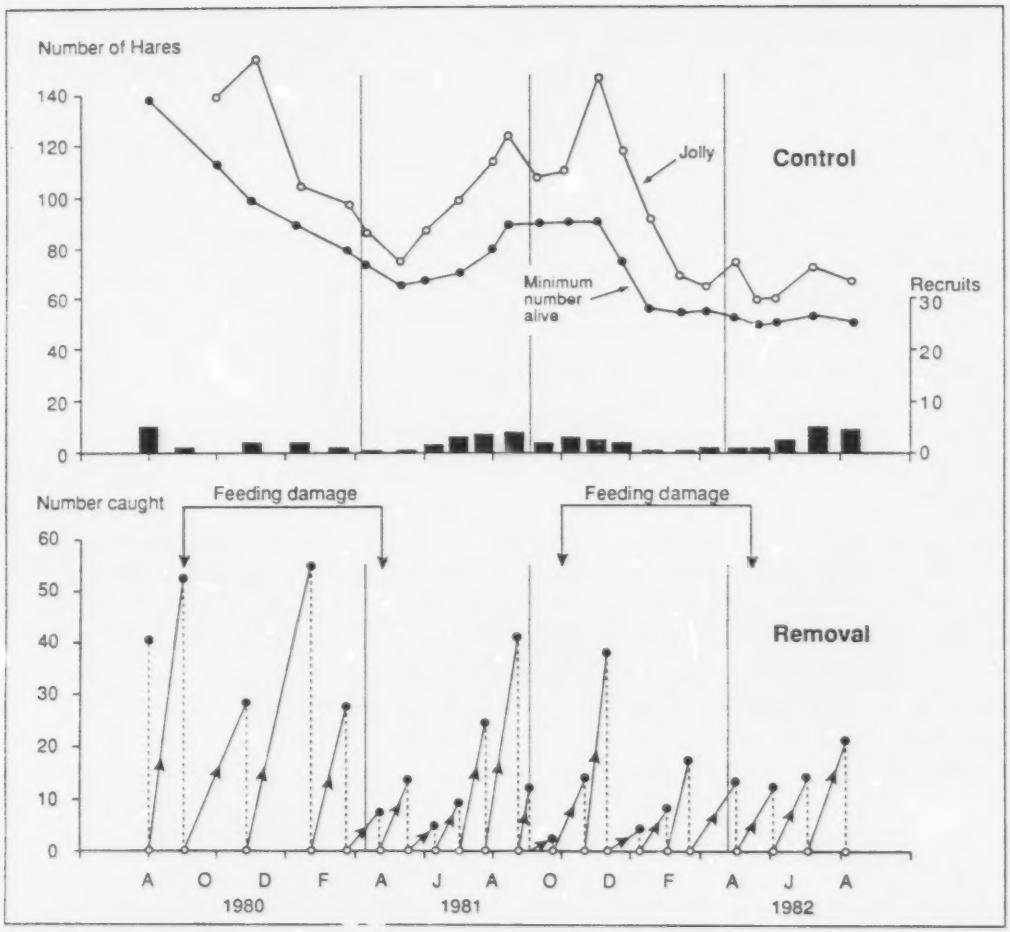

Figure 4 Population densities of snowshoe hares on control and removal areas during the study. Histograms indicate number of new hares recruited into control population. All hares captured during each trapping period on the removal grid were permanently removed. Periods of feeding damage (removal of bark and vascular tissues) by hares to coniferous trees are represented by arrows. Vertical lines mark the limits of summer and winter periods.

stand of lodgepole pine at Bigg Creek, approximately 60 km east of Vernon. This stand was fertilized in the fall of 1986 and has had three spring periods of squirrel attack, to date. Cumulative percentage of trees attacked through 1989 was 76%. Therefore, this stand provided an excellent study area for testing alternative foods (sunflower seeds).

During the first week of May 1989, sunflower seed was spread manually at a rate of 50 kg/ha over a 20-ha treatment block. Nine piles of seed simulating cone or food caches for squirrels were placed within each ha. This process was repeated in mid-June so alternative food was generally available throughout the May to early July damage period.

Provision of sunflower seeds significantly ($p < 0.01$) reduced damage in the treatment block (11.2% of trees attacked) compared with the control (57.5% of trees attacked) (Fig. 5A). In addition, the intensity of feeding, with respect to percentage of stem circumference girdled, in the treatment block was restricted to the 1-25% class only with more intense feeding by squirrels in the control (Fig. 5B). Clearly, availability of alternative food reduced feeding on lodgepole pine trees during the damage period. Therefore, squirrels presumably do not require some essential nutrient present in pine vascular tissues. Rather, they experience a food shortage during May and June which can be accommodated by provision of an artificial food source such as sunflower seeds. This experiment will be followed by an aerial application of sunflower seed on an operational basis in 1990.

RED SQUIRREL AND SILVICULTURAL HABITAT DESIGN

An operational experiment to investigate a range of stand densities of lodgepole pine as a means of "silvicultural habitat design" to reduce feeding damage by red squirrels was initiated in the fall of 1988. Three stands at 500, 1000, and 2000 stems/ha were established near Penticton and Prince George. Responses of squirrel populations with respect to abundance and damage were measured during 1989 (Sullivan 1990).

The responses of squirrels to the various stand densities at each study area are illustrated in Fig. 6. Clearly, significantly fewer squirrels occupied the low-density stand at each area. Conversely, northwestern chipmunk (E. amoenus) populations were more abundant in the low than high density stands (Fig. 7). These results suggest that monitoring of other wildlife species (small mammals and birds) and forage production for ungulates may be prudent in terms of integrated management by silvicultural design (Fig. 8). Incidence of feeding damage in 1989 was low in all stands. This study will continue over a 5-year period and now includes a third installation near Kamloops.

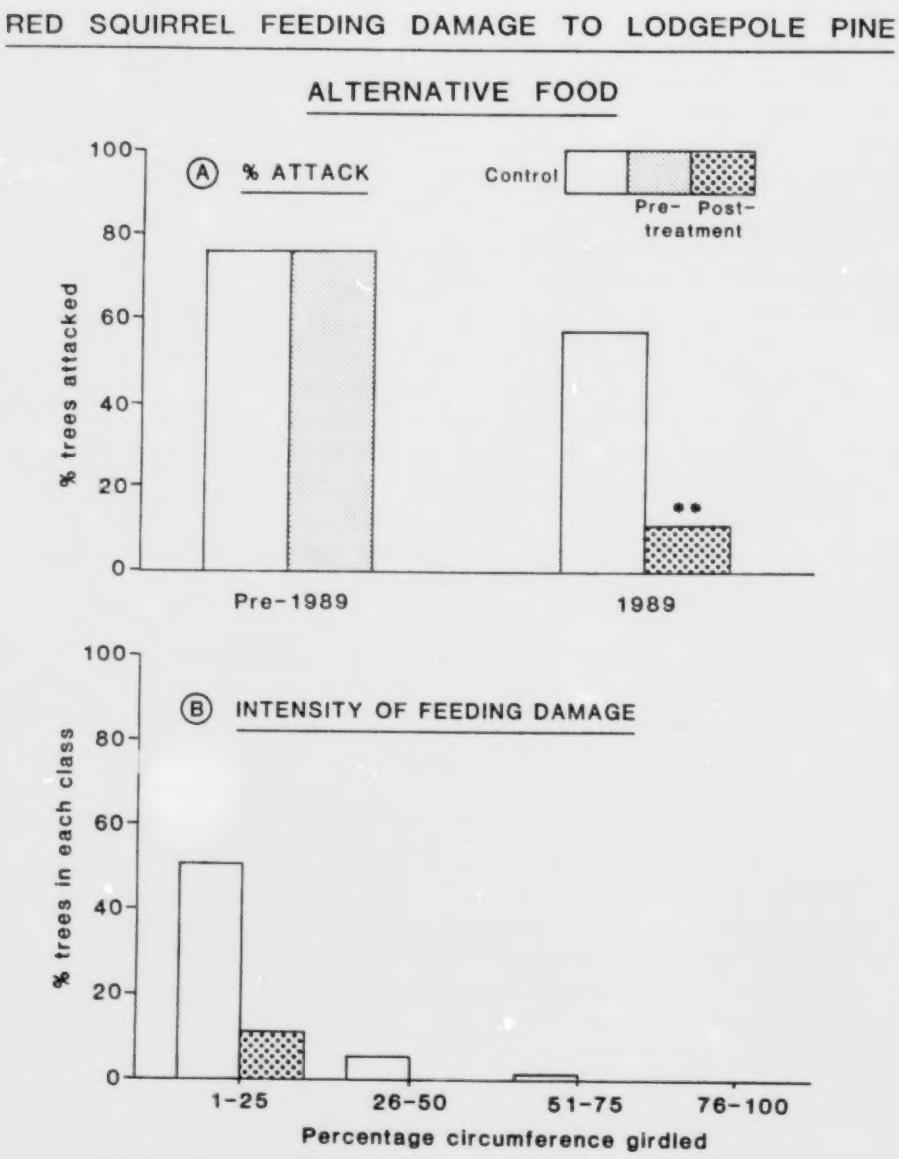

Figure 5 Response of squirrels to alternative foods with respect to: (A) Percentage of crop trees attacked by squirrels, and (B) Intensity of feeding damage by squirrels.

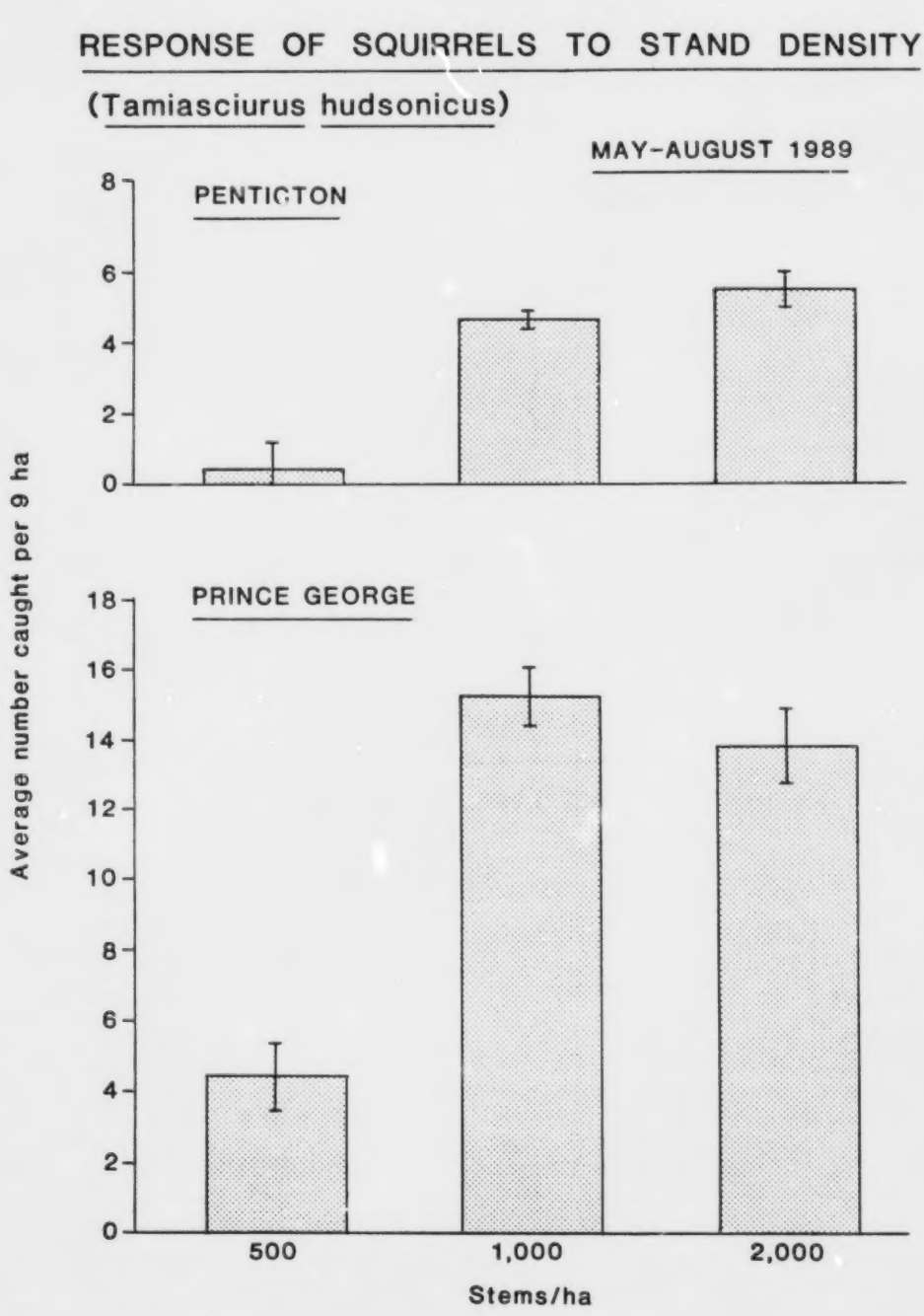

Figure 6. Average number of red squirrels captured during May to August 1989 in the lodgepole pine stands at each study area.

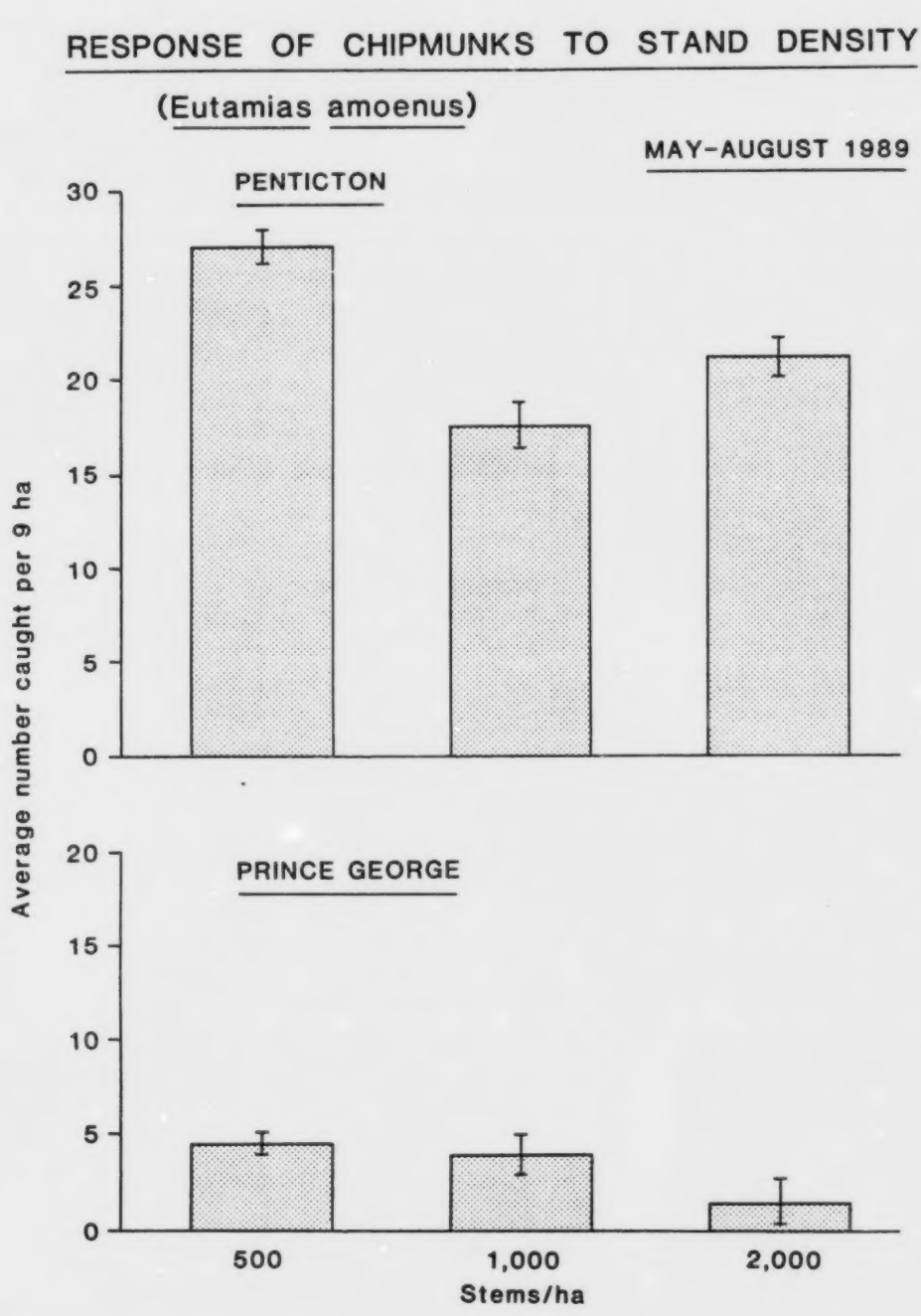

Figure 7. Average number of northwestern chipmunks captured during May to August 1989 in the lodgepole pine stands at each study area.

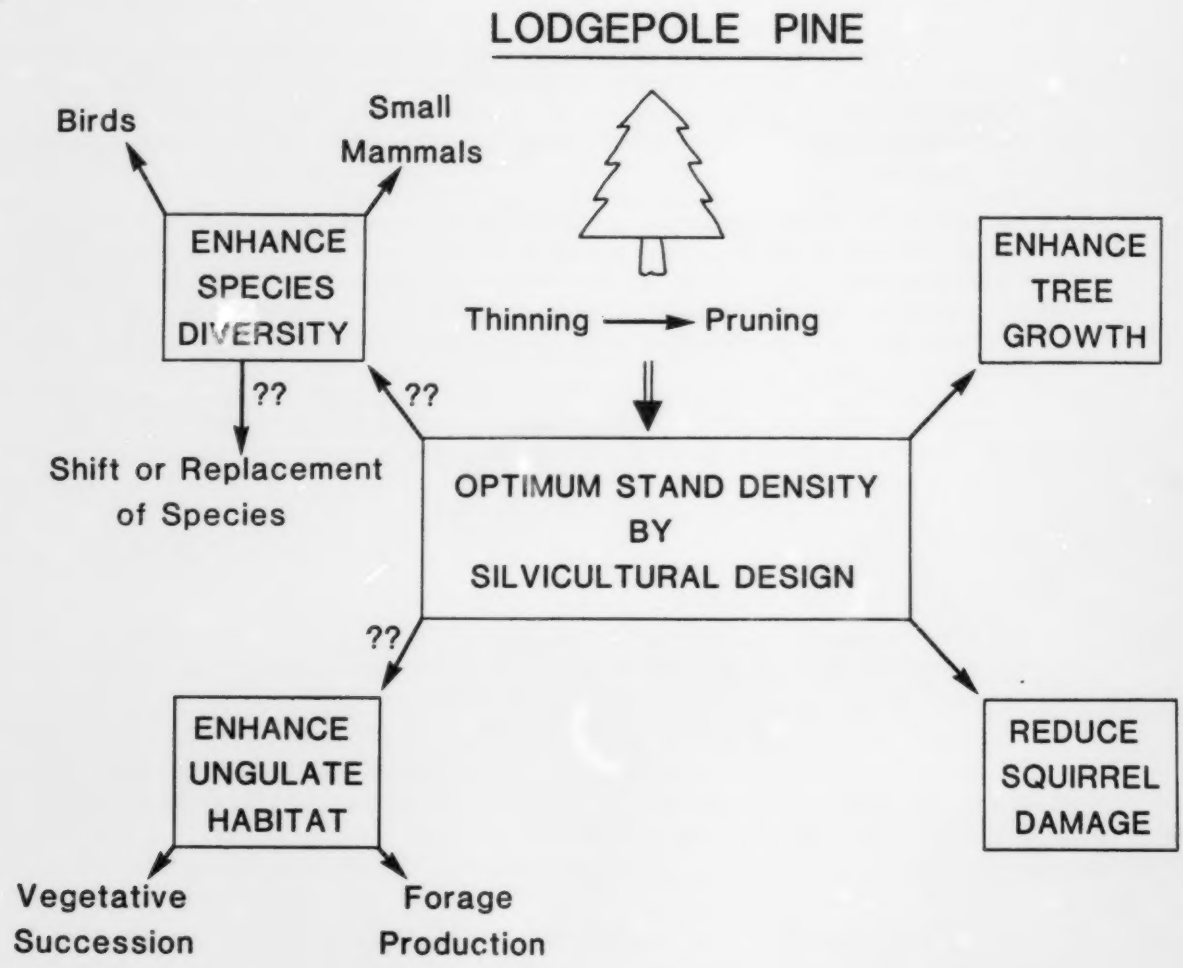

Figure 8. Optimum stand density by silvicultural design in terms of integrated management of forest and wildlife resources.

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ECOLOGICAL (BIOPHYSICAL) INVENTORY, CLASSIFICATION AND MAPPING CONDUCTED BY THE BRITISH COLUMBIA MINISTRY OF ENVIRONMENT

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ABSTRACT

The Ministry of Environment uses a multi-disciplinary, hierarchical classification system as a basis for mapping ecosystems which is based on biological and physical parameters. This classification uses landforms in order to define unit boundaries, which remain identifiable even if the vegetative cover has been modified. Habitat Classes defined in this manner are mapped within a Bioeoclimatic Subzone or Variant which in turn are nested within a regional ecosystem (Ecoregion). This classification hierarchy is designed to provide information at a variety of scales, on land use capability and land use suitability for wildlife planning and management purposes. One goal of this activity is to share a common ecosystem classification with other resource users, such as the Ministry of Forests. However, while there is compatibility at the data collection stages and the identification of most of the classification parameters the purposes for the classifications remain unique.

INTRODUCTION

Ecological (Biophysical) classification and mapping done by the Wildlife Branch of the British Columbia Ministry of Environment is oriented toward identifying habitat for selected animal species. The two main goals of this program are 1) to provide a framework to assess the ability of the land surface for supporting wild animals in its current state (suitability) and under optimal conditions for each species (capability) (Demarchi et al. 1983; Hills et al. 1973) and 2) to provide a framework for improving animal habitat. This program is used for describing and mapping land areas that have relatively homogeneous climatic, physical (including soil) and vegetative characteristics of importance to animals.

The hierarchy used for Biophysical classification and mapping includes Ecoregions, Biogeoclimatic Units (zonation) and Biophysical Habitat Classes (Table 1). Ecoregions are broad, provincial scale ecological units based on climatic processes, physiography, and broad animal and plant distribution (Demarchi 1988; Demarchi et al. 1990). Biogeoclimatic Units, as mapped by the British Columbia Ministry of Forests, provide a climatic framework for mapping within each Ecoregion, as well as a framework for mapping plant community distribution (Pojar et al. 1987). Biophysical Habitat Classes, the lowest level of our classification hierarchy, are relatively homogeneous units with respect to soils, surficial material, bedrock geology, climate, topography, successional trends of vegetation and animal use (Demarchi and Lea 1987) (Figure 1). These classes are divided into successional stages for mapping.

Predictability of vegetation parameters is important in order to determine which

Table 1. Physical and biological parameters that are considered when defining habitat classes at various levels in the British Columbia, Ministry of Environment's Biophysical Habitat Classification (after Demarchi and Lea 1987).

Classification Level	Survey Levels & Common Mapping Scales	Climate	Physical and Biological Parameters Use to Determine Habitat Units at Various Scales			
			Terrain	Soils	Vegetation	Wild Animals
Ecodomain	Global 1:25 000 000	Broad Climatic similarity	-	-	Broad Physignomic groups (formation-type)	Faunal regions
Ecodivision	Continental 1:12 000 000	Climate types	Continental Physiography	-	Similar physiognomic groups (formation)	Life zones
Ecoprovince	Sub-continental 1:5 000 000	Macro-climatic processes	Physiographic systems	Soil Orders	Assemblages of vegetation regions and/or zones	Potential wildlife population ranges
Ecoregion	Provincial 1:2 000 000	Macro-climatic processes	Regional physiography	Soil Orders	Vegetation regions (assemblages of vegetation zone)	Wildlife biogeography (historical and potential distribution of population)
Ecosection	Sub-Provincial 1:500 000	Macro-climatic process sub-regions	Regional physio-graphy: regional bedrock	Soil great groups	Vegetation zones	Faunal communities
Biogeo-climatic Units (Zonation)	Regional 1:250 000	Climatic regimes; macro-climatic parameters	Subdivision of regional physiography to represent groups of local landforms	Soil great groups	Climatic Climax communities	Faunal communities with belts of seasonal habitat use by migratory species
Biophysical Habitat Classes	Sub-Regional 1:50 000	Detailed level meso-climatic parameters	Local landforms; topography (slope, aspect) parent materials	Soil Sub-groups, few classes (texture, depth, moisture, chemistry)	Plant communities (potential successional stages, including climax)	Units of potential and current habitat use by wildlife species
Biophysical Habitat Classes	Watershed 1:20 000	Broad level micro-climatic parameters	Specific landforms and materials, many classes	Soil series, many classes	Plant communities (succession, physiognomy)	The influence of social behavior on distribution and specific habitat use
Biophysical Habitat Classes	Special Area 1:5 000	Micro-climatic parameters	Materials	Phases of soil series	Plant communities many classes	Site specific habitat use

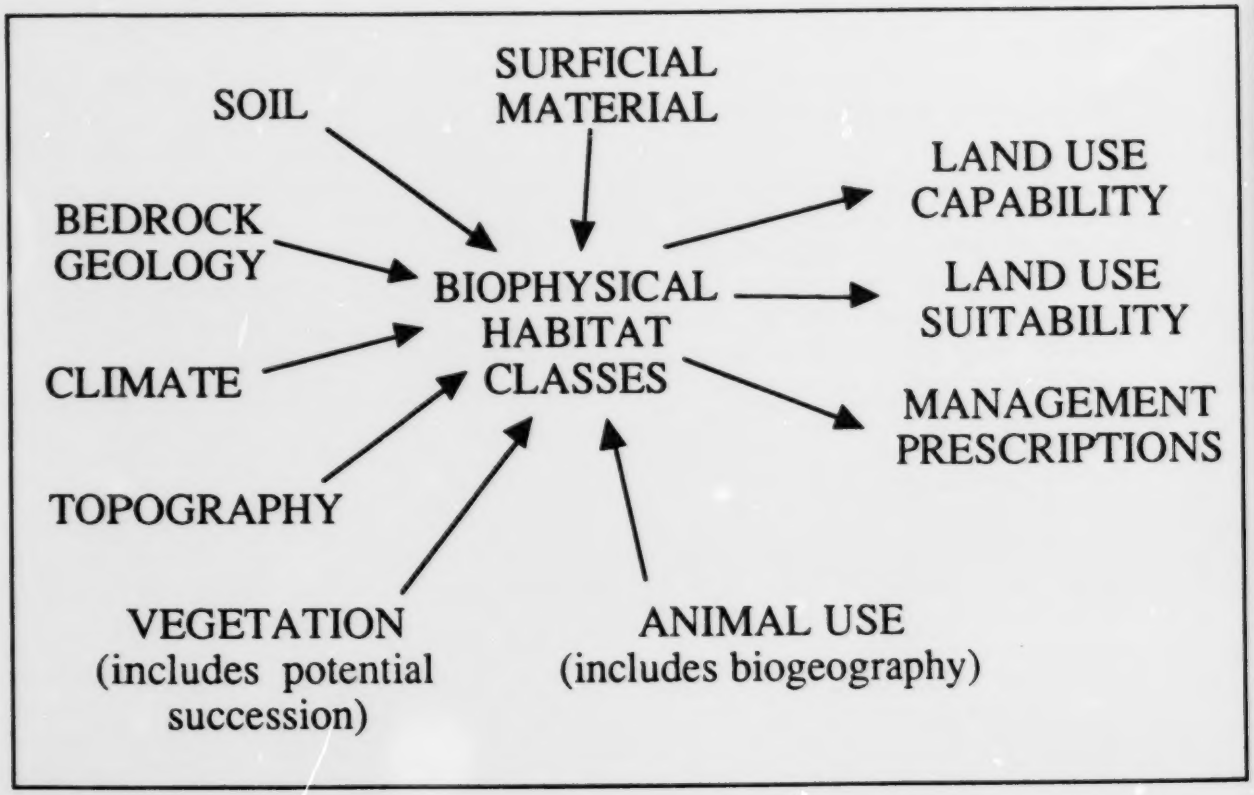

Figure 1. Parameters used to define Biophysical Habitat Classes (after Demarchi and Lea 1987).

areas can be improved for forage and cover for animals. In our classification and mapping, there is a strong emphasis on physicial attributes, and successional as well as climax vegetation, as potential animal habitat use is strongly reflected by these features. The mapping units are based on landform parameters, which represent permanent features of the landscape. Because vegetative cover can change in relatively short periods, units that are based solely on vegetation are quite ephemeral and are therefore less useful for predicting land use capability and land use suitability values.

INVENTORY, CLASSIFICATION AND MAPPING

The use, and more importantly the perpetual use of a renewable resource must be based on an adequate assessment of the stock available. Otherwise use can easily become exploitation which will result in the decline of the amount or availability of the very resources we wish to have. Resource allocation and management must start with inventories and classifications. However, it should also include a mapping activity. Within the Biophysical classification program there are three main activities: inventory, classification and mapping. They can be conducted independently, but they are interrelated.

Natural resource inventory is the counting or surveying of natural resources. It can be quite simple, such as the counting of trees or big game species, or more involved such as with soils, surficial materials, vegetation and climate. The inventory of ecosystems is very complicated, for it requires not only that inventory techniques for various parameters be determined, but that there is a system for placing the acquired field information into a framework or classification. In British Columbia there is a common reference for collecting site, soil, vegetation and wildlife parameters in the field, called "Describing Ecosystems in the Field" (Luttmerding et al. 1990).

Classification is the creation and definition of a set of classes. This is quite distinct from identification, which is the allocation of a newly found object to a predefined class on the basis of its properties (Valentine 1986). Classification involves arranging ecosystems into classes, the members of each of which have a number of common characteristics setting them apart from other classes (Greig-Smith 1964). It can also involve stratification of ecoysystems into hierarchical levels, each of which is defined by different physical and biotic processes or parameters. At any given scale, the parameters that are used to define an ecosystem will vary from those used to define ecosystems at other scales. A clear distinction must be made between the abstract concept of ecosystem classes of different scales, embodied in a system of classification, and the actual existence of those ecosystems. The process of classification is either by agglomerating single examples (individuals), or by dividing the set of all examples (the population), on the basis of common properties and relationships. Either way groups or classes can be identified. The Biogeoclimatic classification (Pojar et al. 1987) is an example of the former, while the Ecoregion classification (Demarchi 1988) is an example of the latter.

Mapping is a process whereby various features and structures that occur in

reality are represented in graphic form. In habitat mapping, the units identified in the field are defined in a classification and then represented by polygons in a geographically based system (either paper or computer). The actual mapping, that is, the delineation of different portions of the area and their description, is done in two main ways: by grouping very small parts of the area that are similar and contiguous, or by dividing the whole area into portions that are different (Valentine 1986). These two procedures parallel those in the classification process. The portions of the map that we delineate and identify with symbols are habitat units.

NEED

The need for habitat inventory and classification is expressed as part of several resource agency goals. The British Columbia Task Force on Environment and Economy (1989) stated that developing a strategy of sustainable development requires a knowledge of the land's capability for production, and that maintaining the stock of ecological capital requires some base-line inventory. The British Columbia Forests Act (1978) calls for an inventory of the lands and forests of the Province and an assessment of the land's potential to produce forage for livestock and wildlife. In the Range Management Program Review, the proposed Strategic Goal #1 is ... "to achieve sound stewardship of range resources by increasing program activities devoted to their measurement, assessment, protection and management" (British Columbia Range Management Program 1989). Recommendation #14 directed ... "increase monitoring of rangelands through application of approved procedures for collecting biophysical data". It is part of the Wildlife Program's guiding principles in the proposed Provincial Wildlife Strategy, that wildlife management should be based on sound ecological principles, and that management emphasis be focused on the health of ecological systems and their ability to support wildlife populations, rather than on the well-being of individual animals. This will be acccomplished by evaluating wildlife species and their habitats, and by carrying out wildlife species and habitat inventories. All this must be conducted using a multi-level ecological classification to establish mapping criteria.

PLANNING

Planning recognizes resource values and allocates resource uses. In British Columbia we are dealing with complex systems and complex resource values. Our task is eased if we can compare the value of different resources in the context of the same area. For example, a planner has a much more difficult task to trade off timber for wildlife if the timber volumes relate to forest cover polygons and the wildlife values are attached to ecological units based on landforms and vegetation. The same spirit of cooperation which generated "Describing Ecosystems in the Field" (Walmsley et al. 1980; Luttmerding et al. 1990) and "Procedures for Environmental Monitoring" (Habitat Monitoring Commitee 1990) is required for an ecosystem mapping methodology; one that builds on the casual factors of site capability.

We are making headway at several fronts. The desire to cooperate has been exemplary at the professional, inventory specialist level. The Biogeoclimatic Classification has become an integral part of the Ministry of Environment's ecosystem classification hierarchy (Demarchi and Lea 1987) (Figure 1). The Prince Rupert Forest Region incorporated the Ecoregion classfication into its 1:500,000 published ecosystem map (Pojar et al. 1988). The Ecological Reserves program will be using both classifications as a means of stratifying the Province in order to define ecological systems (Douglas Ecological Consultants Ltd. 1990). The Royal British Columbia Museum will use a similar description as a means of stratifying the Province in order to define bird habitats and bird resources (Campbell et al. 1990).

Cooperation at the field level does not necessarily translate into cooperation at the Ministry program level. So, while the inventory specialists can accept alternative ways to classify and map resource parameters, overall program directions are still at odds. For example, there are fundamental differences in the Ministry of Environment's use of land use capability and land use suitability concepts, and the Ministry of Forests' use of forest cover and site evaluation. The former are useful for determining not only the present resource values, but for predicting current potential and theoretical potential values. The latter are only useful for determining present resource values.

COSTS

The cost of Biophysical inventory and classification changes as a result of several independent factors. Survey intensity, which is the amount of field sampling and unit checking, is related to scale of mapping, so that more detailed mapping requires more detailed sampling. Remoteness of survey area will increase the survey costs due to increased reliance on helicopters to gain access. Technological input will also increase costs; the trend away from hand-drafted paper maps to automated cartography (Geographical Information Systems) has added greatly to the costs of map production and data dissemination. Unlike humans, which are great for conceptual modelling and for dealing with anomalies, computers require data that are absolutely free of anomalies. The time required to provide such clean data, greatly increases the project costs. This is not to say that the information handling, retrieval and sharing will not be greatly improved at the same time. Some basic costs for producing maps of different planning scales are presented in Table 2.

There is another associated cost, that is the added cost to society of not having an adequate inventory, while still using its resources. The results may be inappropriate use, or it can mean conservative constraints until better information has been acquired. It can also result in loss of productive capacity, loss of biological diversity and unnecessary restriction of future resource management options.

Table 2. Scale of habitat mapping and the cost of producing maps of varius scales in British Columbia

Map Type	Scale and Area of Province	Planning Level	No.of Maps For Each Planning Area	% Completed	Cost/Map
Ecoregion Units	1:2,000,000 Entire Province	Provincial	1	100	-
Biogeoclimatic and Ecoregion Units	1:500,000 Entire Province	Regional	15	100	-
Biogeoclimatic Subzone and Ecoregion Units	1:250,000 Remote Areas	Operational and Sub-regional	42	24	$150,000
Current Habitat Units	1:250,000 Intensive land use areas (detailed mapping to follow)	Timber Supply Area (TSA)	22	36	$30,000
Biophysical Habitat Units	1:50,000 Intensive land use areas	Operational and Planning	360	36	$45,000
Biophysical Habitat Units	1:20,000-1:5,000 Special projects	Operational	undetermined	-	$20,000

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THE WILDLIFE HABITAT HANDBOOK: MEETING THE NEEDS FOR DIVERSITY MANAGEMENT

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ABSTRACT

The Wildlife Habitat Handbook project was conceived in 1982 to develop planning tools that aid wildlife habitat management. The Southern Interior Ecoprovince was designated as the location for the development of a pilot handbook. Handbooks being developed in the United States were used as initial blueprints for this project.

A habitat handbook can be defined as a publication that organizes relevant knowledge of wildlife species and their use of habitat in a readable, understandable format; the key concept is that the handbook provides the best existing knowledge on the habitat requirements of wildlife species and on how forest activities affect these needs. The handbook is a tool to help managers to make better analyses and decisions in meeting objectives for diversity and featured species management.

The Wildlife Habitat Handbook for the Southern Interior Ecoprovince provides habitat information for 145 species of amphibians, reptiles, birds, and mammals. Specifically, the information will be provided in eleven volumes, eight of which are now printed.

The success of this project is closely linked to changes in wildlife program direction over the past few years, that are creating a real rather than perceived need for this form of predictive information. This is especially true for developing a wildlife diversity approach that considers all species in an area.

INTRODUCTION

During recent years, the term "handbook" has been used for a wide variety of biological publications. Some kinds of handbooks may provide management direction in the form of guidelines (e.g. Coastal Fish/Forestry Guidelines) or simply biological information (e.g. Provincial Museum handbooks). A habitat handbook is defined as a publication that organizes relevant knowledge of wildlife species and their use of habitat in a readable, understandable format. The key concept is that this form of handbook provides the best existing knowledge on the habitat requirements of wildlife species and on the consequences of potential forest activities affect these needs. The manager then must use this knowledge to achieve his stated objectives of protection and production for both wildlife and the other resources being managed.

WILDLIFE DIVERSITY

The mission of the Ministry of Environment's wildlife program in British Columbia is to maintain an optimum balance between ecological, cultural, economic, and recreational needs of modern society. This can be translated, in part, to a mandate to

manage for long-term survival of all wildlife species; that is, manage for diversity. Diversity can be defined as the richness and diversity of life within a geographic area (e.g. stand, watershed, ecoprovince) (Salwasser 1986). Wildlife habitat diversity is created by the abundance and arrangement of different plant communities and geographic features within a specific area. Maintaining a variety of wildlife habitats ensures species richness and promotes population stability, as well as being a key factor in maintaining viable populations of wildlife (Brown 1985). The value of a diverse and dynamic wildlife resource goes beyond economics and sentimentality. We, as resource managers, have a stewardship or moral obligation to manage wildlife wisely. Wildlife plays a key role in ensuring ecological sustainability. Thus, an approach to management that will encompass diversity of wildlife and their habitats will provide a firm support for ensuring healthy ecosystems and pursuing sustainable development for the future.

British Columbia has a land area of almost 95 million ha, with a diverse physiography, climate, fauna, and flora. About 90 percent of the province is in the mountainous Canadian Cordillera, while the northeastern corner is in the flatter Interior plains region. Of the five ecological domains described for North America (Bailey 1980), three are present in British Columbia. There are ten ecoprovinces, which are subcontinental-level units based on major differences in macroclimate-physiography interactions and resulting in characteristic combinations of vegetation zones on a vertical transect (Demarchi *et al.* 1990). The natural vegetation, superimposed on this landscape, has a wide variety of successional stages and land uses; this results in a highly complex and varied mosaic of habitats.

The vertebrate fauna is comprised of at least 1081 species, including 451 fishes, 19 reptiles, 20 amphibians, 448 birds, and 143 mammals (Cannings and Harcombe 1990). The majority of the latter four classes are nonmarine, with a strong affinity to terrestrial systems and forested land. Many of our species are not found in other parts of Canada. In addition to using wildlife for recreational and commercial purposes, British Columbians benefit from its presence, whether or not they encounter animals in the field. It is part of our heritage, and its existence adds to the variety and richness of citizen's lives. It is evident that B.C.'s wildlife heritage is highly valued and extensively used. Wildlife not only enhances the everyday life of most residents, but is a vital contributor to the health of the provincial economy.

MANAGING FOR WILDLIFE DIVERSITY

The legislative mandate for managing wildlife and habitat is primarily divided among three Ministries. The management of wildlife is the mandate of the Ministry of Environment. The responsibility for management of the habitat (i.e. lands and vegetation) is divided between the Ministries of Forests and of Crown Lands. These two provincial Ministries have this mandate over most of the provincially owned land base (about 93 percent of the province). Forests has the major role in multiple resource decisions affecting land use. The planning process is supposed to coordinate and integrate other natural resource values such as fish and wildlife with

forest and range resources. Crown Lands has a primary orientation to single land use. Wildlife biologists are slowly becoming more involved with the integrated planning processes of the Forest Service; the translation of the integrated resource statement of the Forest Act into meaningful action is in process. For example, wildlife is now a formal proactive participant in the TSA planning process, and wildlife needs are being included in forest options and being discussed as something more than constraints to timber cutting.

The principal goals of the wildlife management program are:

1. to maintain and enhance wildlife and their habitats to ensure an abundant, diverse, and self-sustaining wildlife resource throughout British Columbia;

2. to maintain, enhance, and promote viewing and appreciation of wildlife in their habitats;

3. to maintain, enhance, and promote recreational opportunities to hunt game species in their habitats;

4. to facilitate commercial uses of wildlife; and

5. to protect people and their properties from intolerable levels of danger, damage, or harassment by wildlife.

There are concerns about diversity in British Columbia because there are weaknesses inhibiting our progress in achieving our primary goal. This is reflected by such things as a poor prognosis for the long-term health of many wildlife populations (Wildlife Branch in progress) and increasing awareness of public pressures to actively manage for a greater variety of wildlife and to change our way of doing business. British Columbia has no legislation that mandates that diversity concerns must be considered in land management plans. Therefore, wildlife managers need to resolve a number of these weaknesses, concurrently with the development of planning tools, before an effective approach to diversity planning and management can become a reality. Over the past three years, some of these weaknesses in the management framework that are being worked on are:

1. increasing our knowledge about present status for many species, to a higher level of reliability

2. having provincial-level approach to defining ecologically-based areas for developing management strategies and diversity objectives

3. having a more consistent level of habitat classification that can be used at a variety of geographic scales

4. having all wildlife legally defined as wildlife and therefore be included in our management mandate

5. having wildlife program goals and objectives clearly defined and supported by both government and the public.

6. having more public awareness and support to manage all species

7. understanding of economic value of wildlife;

8. clearly identifying moral obligations for maintaining ecological sustainability (long-term health of ecosystems);

9. having full participation from all resource agencies;

10. having a planning process that will seriously consider wildlife and habitat needs, and clearly show relationships between decisions reached at the different planning levels;

11. changing our attitudes towards managing first for all species viability and then to meet specific production goals.

The pieces of the puzzle are falling into place, so that the development of wildlife-timber tools has the potential to be useful in achieving resource objectives. However, even when the actual tools are developed, there are two problem areas that still need resolution before they can be fully implemented--setting diversity objectives for specified species and habitats, and incorporating concerns about continued fragmentation of habitat.

THE WILDLIFE HABITAT HANDBOOK

The Wildlife Habitat Handbook program was initiated several years ago in British Columbia to provide managers with the capability to make better analyses and decisions in meeting objectives for wildlife diversity through the application of species-habitat tools. A promising approach was being produced by the wildlife fish habitat relationship (WFHR) program in the National Forests of the United States. At present, a major portion of B.C.'s provincial program for diversity management is aimed at providing adequate habitat to support viable populations of all wildlife species within their historical areas, although it is acknowledged that other factors such as predation and competition are important.

Now that wildlife diversity is the acknowledged primary goal of the wildlife program, the issue of concern for the Wildlife Habitat Handbook program is to develop a system, with appropriate tools, to help plan for this diversity. This package of tools, to be used to analyze impact of habitat change on a selection of species, is the

primary focus of the Wildlife Habitat Handbook program. Guiding principles for the needed system are that it must:

1. be easy to use
2. be based on existing information
3. consider all wildlife species
4. consider all essential habitat requirements for species
5. be linked to current inventories of forest resources
6. be usable by forest and habitat managers
7. be computer-based and available in MOE regions and MOF regions and districts
8. be useful at a variety of scales and planning levels
9. provide a way of evaluating changes in species diversity for a variety of forest management options.

The scale of diversity analysis will impact the management objectives but the components of the tool should remain relatively constant. Therefore, at regional scales (e.g. Timber Supply Area [TSA], Tree Farm License [TFL]) one would be concerned about impacts of habitat requirements that might have a significant implication to the amount of timber available for cutting. At the watershed level, one would be more concerned with the location, pattern, and scheduling of habitat prescriptions, possibly for only a subset of wildlife species. At the forest stand level, one would be most concerned with such attributes as cutblock size and shape, impact of edge, and specific habitat elements (e.g. snags, downed material), and obviously, an even smaller number of wildlife species.

THE NEEDED TOOLS

The Wildlife Habitat Handbook gives the wildlife manager a tool that:

1. can be related to other resource inventories (e.g. forest cover)
2. can show trend changes in suitability of a planning unit (e.g.the watershed of 20,000 ha) for a particular species
3. can provide the opportunity to assess a planning unit for all species of

wildlife

4. can translate suitability into population density potentials.

The Habitat Handbook is based on an organized set of knowledge about the relative capabilities of different environments or habitats to support wildlife. It contains models that help predict consequences of contemplated forest management on wildlife, but not provide rigid guidelines. These models, however, are in a form that does not require the manager to spend a long period of time hand-colouring maps, compiling total areas of each habitat, looking up models in a large book, or doing innumerable calculations by hand. The species-habitat models are linked in a system to an automatic compilation of kinds and relative amounts of wildlife habitats, so that one must only select "species of interest" and "area of interest" to perform an assessment on present habitat suitability. It would be best if the habitat could be made to "grow" over successional time intervals, so when management scenarios were superimposed, consequences based on changing habitat suitabilities would result. However, this is not a part of the pilot effort. Results are in suitability values, illustrated in both tabular and graphical formats, and attempt to translate suitability value into population estimates. Obvious benefits include rapidity of analysis and ease of application.

WILDLIFE DIVERSITY MANAGEMENT TOOLS

The wildlife diversity management tool for British Columbia will be a computerized analytical framework for compiling types and amounts of habitat in a planning area, linking this matrix of values to selected species requirements (in the form of simple species-habitat relationship models), and producing habitat suitability values that can be translated into potential population densities. When habitat is modified by either succession or management practice, the system will derive a changed set of habitat suitability values.

The tool is intended to be used by either a forester or a biologist. However, the interpretation of the results and their relationship to meeting diversity objectives for the planning area must be done by the professional biologist. The system is intended to provide a tool for evaluation and understanding, not to design a set of guidelines for the land manager. All species are potentially available in the analysis. However, those that are either rare or require large home ranges will not give reasonable results.

This tool requires:

1. species notes describing habitat requirements of wildlife (four volumes)

2. models that evaluate the suitability of successional stages within habitats for seasonal wildlife needs (four volumes)

3. a description of major wildlife habitats and special elements for the

ecoprovince, including subdivisions and the relationship of this classification to other classifications

4. a description of silvicultural activities and options within the major forested habitats, relating these activities to changes in succession

5. an automated system utilizing geographic information systems to compile amounts and types of habitat within a planning area and link this to a user-selected group of wildlife habitat models, to assess changes in habitat suitability over time for one or more management scenarios

Products 1 and 2 have been completed. If you are not on the official WHH mailing list, limited additional copies are available. The habitat report will be finished shortly. Products 4 and 5 will be completed in the upcoming fiscal year; the silvicultural report will be contracted, hopefully using regional forestry coordination, while the automated system has been designed and now needs to be developed into an easily-used package. The prototype system will be demonstrated for a 24,000 ha watershed for the Louis Creek valley, northeast of Kamloops in the Southern Interior Ecoprovince.

The species-habitat models used in the Wildlife Habitat Handbook are not complex. The habitat classes are fairly broad, so that within a biogeoclimatic subzone, one might find only three forested habitats: dry, mesic, and wet. For some wildlife species whose habitat relationships are well-known (e.g mule deer, moose), this is simplistic. For little-known species (e.g. long-tailed vole), this is complex. These models were compiled by a group of species experts, based on their professional expertise combined with known information from the literature (compiled as species notes or narratives, on habitat requirements for various life functions such as feeding or reproduction). The habitat classification is based on a province-wide system developed for the regional habitat plans. Habitat classes are directly linked to ecosystem associations of the B.C. Forest Service; they can be interpreted from forest cover data in combination with biogeoclimatic subzones. The models are the best we can presently do without extensive delays to accumulate new knowledge. They are aimed at indicating potential direction in population trend with changing habitats. When suitability values are plotted over time, as habitat changes, it is possible to get an indication of impact direction for each species (i.e. population increasing, population decreasing, population relatively stable).

The recent advent of PC-based geographic information systems (GIS) has led to a major advance in technical support for map products. If habitat units can be mapped or correlated to existing mapped units (i.e. through "crosswalk" or look-up tables), GIS becomes a means of compiling the habitat inventory. A major problem in British Columbia is the incomplete status of digitized databases and the cost of GIS hardware and software. However, GIS equipment is presently being installed in Forest Service regions and districts, and is being actively assessed for regional offices of the wildlife program.

UTILIZATION AND USE OF THE SYSTEM

Because some of the diversity system will be a software tool, it should be easy to put into use in the field and the regions. It is anticipated that, initially at least, the existing habitat inventory for a selected area will be compiled by the forester, since they have access to the digitized map base of forest cover. As better habitat maps become available in digital form, they will provide much better ecological knowledge on types and distribution of wildlife habitats. The actual species selection will be the role of the biologist. Various scenarios should be jointly prepared, based in part on watershed development plans and partly on proposed wildlife objectives for an area. For the pilot project, two or three scenarios will be prepared for evaluation. The use of the system will be shown in two ways; onsite extension and demonstration, using the pilot watershed data, and by user manual. It is planned that the tool will include various help screens, so that this "manual" is included with all software.

To date, it has proved very difficult to fully visualize the final tool and its needed outputs formats because it has been difficult to ask the biologists the right questions without some real "hands-on" material. There is a need to work closely with these regional biologists, since their help will be needed in setting up good ways of choosing species and generating habitat scenarios. They will set habitat objectives and guidelines from the output data. I envision that a lot of regional interaction will be necessary before a final tool is operational.

QUESTIONS

There are a number of important questions still in need of resolution. Most have to do with using the tool in a manner that is connected to approved objectives and how the various outputs can be used to help in making good management decisions without becoming inflexible. There is the need to improve the "habitat growing" portion of the tool; it would be best if successional change could be included in the model, and if there was an easier way to incorporate changes derived from management scenarios. There is the important questions of selecting species, especially in light of the experiences of the National Forest managers. There is the growing need to pay more attention to impacts of habitat fragmentation and genetic viability.

RISKS

The major risk in the whole issue of assessing wildlife values for a planning area is related to the reliability of the models in predicting changing animal response to changing habitat structure. If the critical factors that a species responds to are not a part of the habitat attributes used in the models, then the models' predictive accuracy will be low. There is a risk that the model will not be sensitive enough to identify a significant change in suitability caused by habitat change.

Sophistication is needed at the management level. There must be a suitable selection of species, keeping in mind the described problems with management indicator

species. This selection must reflect higher planning decisions. There must be adequate objectives set in terms of desired products for the watershed. Finally, the tool results must be professionally interpreted by biologists and translated into guidelines for subsequent management actions. The most difficult task will be attempting to provide for a diverse set of wildlife that have very diverse habitat needs. Each watershed cannot provide everything; hence, diversity objectives must be set for the ecoprovince and translated for the TSA or TFL.

The risk of not using these models is the risk of failing to address the program's primary goal by any means other than "good timber management will be good wildlife management". Sufficient reliability is a difficult concept to measure. Model structure has been evaluated by the recognized experts, who have assessed the probability of the model predictions being correct.If the models then give results that a professional biologist would deem possible, then the models are probably reliable enough for the first cut. They can be improved as our knowledge improves; they are not set in stone. Direct field validation is very expensive and time consuming. Much of the benefit of using a diversity management system is an attempt to consider a variety of species beyond those traditionally considered. The tool framework can be used with more detailed models if necessary to better predict population densities for meeting population objectives. Geographic information systems are a critical tool in allowing easier assessment and manipulation of mapped data and production of interpretive products. The Wildlife Habitat Handbook approach is used extensively in the National Forests of the United States; forest biologists and managers are using these tools to build in diversity criteria to their forest plans, as they are legally mandated to do. For the first attempt, they are certainly superior to ignoring the majority of species. Models are meant to mimic reality; if we perceive that they do a good job, then we will make use of them.

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THE NEED FOR WILDLIFE/FORESTRY GUIDELINES IN BRITISH COLUMBIA

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ABSTRACT

Wildlife/forestry guidelines are required in British Columbia, so that wildlife habitat concerns are addressed during forestry operations. The guidelines would be used to encourage logging and silviculture activities that would maintain or enhance local biological diversity. Cooperation between government and industry is a key element needed to produce effective guidelines. Wildlife/forestry guidelines are expected to improve the management of the public resources by: emphasizing wildlife management efforts on the highest value habitats, shifting responsibility and accountability for maintaining habitat quality to those directly altering it, improving understanding among all parties and reducing time required for environmental review. The incentives for cooperation are: improved public confidence in management of their resource, increased understanding of wildlife species and habitat requirements and shortened review time required for logging plans. Other alternatives such as management by regulations may provide less flexibility and provide lower overall quality for integrated resource management.

INTRODUCTION

Wildlife/forestry guidelines must be for the maintenance of all species not just big game species such as deer, moose and elk. Because British Columbia has such tremendous biological diversity in wildlife species (approximately 640) and habitats that support them, creating wildlife/forestry guidelines is much more complicated than creating fish/forestry guidelines.

Wildlife/forestry guidelines are needed to improve the management of the public resources by emphasizing wildlife management efforts on the highest value habitats, shifting responsibility and accountability for maintaining habitat quality to those who directly alter it, improving understanding among all parties and reducing time required for environmental review.

The objectives for operational wildlife/forestry guidelines are to:

1. communicate wildlife program objectives
2. streamline the development plan referral process
3. transfer responsibility and accountability to those altering habitat
4. improve understanding and cooperation
5. ensure equitable treatment of similar activities in similar environments

When creating any form of guidelines, the first step is to identify management objectives. Once management objectives for each resource are developed, then a cooperative process involving all affected parties can be undertaken. A consensus by all participants is needed before the guidelines can be completed.

Before addressing wildlife/forestry guidelines, let's review existing guidelines.

EXISTING SIGNIFICANT GUIDELINES

Three significant wildlife/fish/forestry guidelines are presently in operation in the Pacific Northwest. Each was developed through a process that first identified management objectives for all resources, followed by discussion among resource users on alternatives. Finally, by consensus, a set of actions on these objectives was achieved. All participants also agreed to implement and monitor the guidelines for a fixed time and then reassess and modify them as necessary. These guidelines each address forestry practises such as planning, construction of roads and landings, road de-activation, selecting harvesting and silvicultural systems, determining cutblock sizes, and scheduling of harvests. They are summarized below. Their strengths are emphasized so that these can be considered when wildlife/forestry guidelines are developed for British Columbia.

TIMBER/FISH/WILDLIFE AGREEMENT (TFW) (Washington State, 1987)

After 15 years of battles in courts, legislatures and government departments over forestry, fisheries, wildlife and water quality, the forestry industry, state agencies, native and environmental groups agreed that a consensus approach would be more productive. Cooperation was the key to the success of the TFW Agreement. Washington State was changed from a regulation-based system where resource users were required to do only what the regulations stated to a system based on managing towards certain goals.

A court decision led to the cooperation needed for the TFW Agreement. The incentive for cooperation among the major conflicting interest groups was the fear that if they could not agree then the legal system through judges and lawyers was going to make the resource management decisions for them.

The differences in the land tenure and forest legislation have no parallel in British Columbia. The factors considered and a similar sequence need to be addressed when developing guidelines in B.C.. The TFW sequence includes:

1. Identifying basin, region, or state-wide resource goals for timber, fish, wildlife, water.

2. Developing monitoring/evaluation techniques to determine if goals are being met.

3. Developing risk assessment techniques to anticipate reducing or avoiding violation of goals.

4. Altering management practices or regulations to the extent necessary to attain goals

5. Re-evaluating goals as new information becomes available.

Timber, fish and wildlife goals are sometimes in conflict. Establishing ground rules to foster cooperation in the TFW process was a strength that helped participants to come to a consensus. Some of the rules were (Waldo 1988):

1. leave your arms at the door.

2. separate personalities from issues.

3. spend as much time listening as you do talking.

4. fix problems and not blame.

5. agree that objectives of others are valid.

6. reserve the right to go back to techniques used before.

7. put participation as a priority, with commitment up front.

8. if anyone believes they can win or lose they won't participate

9. cooperation doesn't mean, do it my way.

10. you don't always get what you want.

Waldo (1988) also advised that to be successful the following questions regarding guideline development must be answered positively:

1. are the news media supportive?

2. are the elected officials supportive?

3. are the communications feed-back loops working?
   Negotiators can agree but their groups may reject the agreement.

The TFW Agreement applies to all land including private. Inter-disciplinary teams are used for on site review and evaluation, which is a real benefit in areas where the

practises need to be tailored to the site and situation. The inter-disciplinary teams must have technical expertise in soils, geomorphology, geology, hydrology, fisheries and wildlife biology, and forest engineering, and include technical experts from the native tribes, industry and elsewhere. The TFW agreement is primarily directed towards fisheries and management of fish habitat. Riparian Zones are described and subject to most of the special regulations. Upland management areas address wildlife needs for diversity of daily and seasonal habitats. The agreement calls for at least 0.8 ha (2 acres) of upland management areas for every 65 ha (160 acres) clearcut harvested.

THE OKANAGAN TIMBER SUPPLY AREA (TSA) GUIDELINES
(Southern British Columbia, Okanagan Resource Guideline Committee 1988)

This set of resource guidelines for forestry addresses wildlife, water and fish recreation and aesthetics requirements at the subregional level. They were developed through cooperation of the Ministries of Environment (MOE) and Forests (MOF), Department of Fisheries and Oceans (DFO) and major forest industry operators in the Okanagan TSA. A consensus approach was used. The wildlife habitat management objectives were to maintain habitat diversity and thus ensure species diversity. The land base was divided into five zones: integrated management, community watershed, winter range, riparian and lakeshore zones. Size, shape, pattern, timing of green-up for clearcuts and areas where selective logging was favoured were specified for these various zones. All aspects of roads from planning, construction, maintenance to deactivation are addressed. The resource emphasis zones are easily identified with streams and lakes listed in the appendix. Only winter ranges have been mapped at a broad regional scale (1:250 000).

COASTAL FISH/FORESTRY GUIDELINES (CCF)
B.C. Ministry of Forests et al. 1988, British Columbia Coast

These guidelines were developed by MOE, MOF, DFO and the forest industry represented by the Council of Forest Industries. A steering committee was struck and a number of subcommittees formed to work on the major tasks such as roads and landings, falling and yarding, and silvicultural practises. A cooperative consensus process using operating experience and the most current research led to the successful completion of CFF guidelines. A real strength of these guidelines is the simplicity with which they communicate habitat management objectives. The four stream reach classes are linked to stream gradient so that field foresters can identify habitat and management objectives directly.

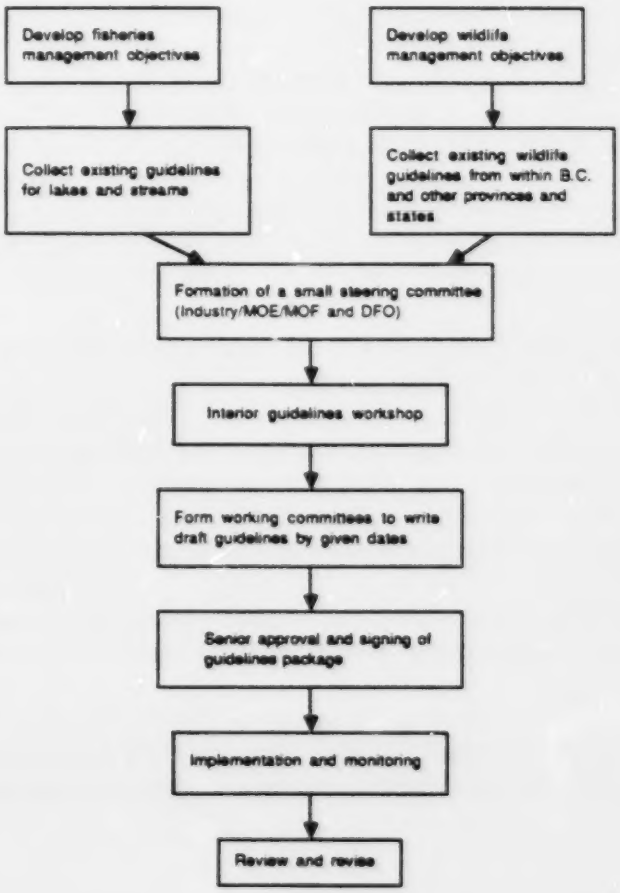
These guidelines have been implemented for a 2-year trial and will be reviewed and revised in the future. The guidelines were aimed at 5-year development plans.

INTERIOR GUIDELINES PROCESS

After the success of the CCF guidelines there has been a push to formulate similar guidelines for the Interior of British Columbia. The process to develop Interior guidelines has begun and will include wildlife. These guidelines will also be operational, and developed through a similar process to that of the CCF guidelines. This means the decision to harvest an area has already been made and the guidelines will focus on how forestry practices can better achieve habitat management goals. The guidelines will not be used to determine whether the area should be logged. The decision on the level of harvest, the annual allowable cut, is determined at the Timber Supply Area level of planning.

This paper only discusses the Wildlife Program progress towards formation of wildlife/forestry guidelines. To date the Wildlife Program and regional habitat staff have had some internal debate to clarify the type of guidelines that would be best to improve and integrate habitat management and forestry operations (Fenger and Stevens 1989). Existing guidelines have been collected.

The steps needed to develop these guidelines are as follows:


Develop fisheries management objectives
Develop wildlife management objectives
Collect existing guidelines for lakes and streams
Collect existing wildlife guidelines from within B.C. and other provinces and states
Formation of a small steering committee (Industry/MOE/MOF and DFO)
Interior guidelines workshop
Form working committees to write draft guidelines by given dates
Senior approval and signing of guidelines package
Implementation and monitoring
Review and revise

The major task of the Wildlife Program will be to set habitat management objectives for the variety of habitats and species present in the Interior. This is currently underway at several levels within the Wildlife Program for the province. A sustained effort by the Program will be needed to translate these objectives into a form useful to operational forestry and guidelines development.

The rest of this paper describes what has been completed within the Wildlife Program to set habitat management goals provincially and regionally so that there is an understanding of the process. Also described is the additional work that will be needed to set operational habitat goals on which to base wildlife/forestry guidelines.

SETTING GOALS AND OBJECTIVES FOR HABITAT MANAGEMENT IN B.C.

The Provincial Wildlife Strategy and Species Plans

At the provincial level, the Wildlife Program has laid out a Provincial Strategy to the year 2000 (Ministry of Environment, in preparation).

The Mission statement and the main goals are:

> To manage the Province's wildlife resources for the benefit and enjoyment of British Columbians, by maintaining an optimal balance between ecological, cultural, economic and recreational needs.

This Mission Statement is expanded into five goals, the first is the most important for without this the others cannot be achieved.

GOAL: To maintain and enhance wildlife and their habitats, and thus ensure an abundant, diverse, and self-sustaining wildlife resource throughout British Columbia.

GOAL: To maintain, enhance and promote opportunities to appreciate, study and view wildlife in their habitats.

GOAL: To maintain, enhance and promote opportunities to hunt game species in their habitats.

GOAL: To facilitate the commercial use of wildlife.

GOAL: To protect people and their property from intolerable levels of danger, damage or harassment by wildlife.

At the provincial level there are a series of Wildlife Species Plans in which habitat requirements are clarified. These plans do not address all 640 species of wildlife in the province but concentrate on certain species or groups of species that

are threatened and endangered or of management concern.

Wildlife Species Lists (endangered, threatened, red, blue, and yellow)

For guidelines, habitat objectives for some of the 640 wildlife species with differing seasonal habitat requirements for food, shelter, and reproduction must be defined. To make this task more manageable, species have been ranked into groups requiring differing degrees of management, based on criteria such as reproductive rate, susceptibility to disturbance, low numbers, poor understanding of habitat requirements, present population status, and public demand. The lists have been color coded to reflect degree of management concern with the red-listed species most in need of attention, followed by the blue and yellow lists. Unlisted species are considered sufficiently protected under current management and do not receive special attention. Threatened and endangered species naturally receive first priority.

There are four species listed as threatened and endangered, 25 red-listed species, 76 blue-listed species and 88 yellow-listed species. Thus, the 640 have been reduced to 189 species that receive greater management attention. Not all listed species are affected by logging. Most of the high profile species will have the habitat requirements addressed at strategic levels or regional planning levels.

Regional Wildlife Plans

The 10 Regional Wildlife Plans set regional management objectives and tie habitat requirements and wildlife together (MOE in prep.). A broad set of habitat classes (Table 1) and management strategies for each class are used in these plans. These regional plans lack mapped habitat class information, but a set of Regional Wildlife Habitat maps identify the important habitats and major species. These maps use an ecological framework set by biogeoclimatic subzones and ecoregions. Detailed habitat maps and management objectives are currently available for only a few areas.

Integration of MOE and MOF Plans

The regional MOE input to forest planning and integration of habitat and timber takes place by review and participation in the TSA level plans (Fenger and Stevens 1990). The change in the scope envisaged for these plans and the integration of all resources need to be strengthened if operational guidelines are to be effective. There needs to be a link from these broad plans to what the guidelines suggest should be carried out on the ground.

HOW OPERATIONAL WILDLIFE/FORESTRY OBJECTIVES COULD BE DEVELOPED

Habitat biologists have met and agreed that an ecological approach towards wildlife/forestry guidelines is needed (Fenger and Stevens 1989). Wildlife/forestry

Table 1. Habitat Classes for British Columbia

Forested Habitat Classes (52)

Amabilis fir - Douglas fir
Amabilis Fir - western redcedar
Amabilis fir - yellow cedar
Black cottonwood riparian
Black spruce - lodgepole pine
Black spruce bog
Boreal whitespruce - lodgepole pine
Boreal white spruce - trembling aspen
Cedars - shore pine bog
Coastal Douglas-fir
Coastal western hemlock - Douglas fir
Coastal western hemlock - subalpine fir
Coastal Western hemlock - western redcedar
Coastal western redcedar - grand fir
Douglas fir arbutus
Douglas-fir - lodgepole pine
Douglas-fir - ponderosa pine
Engelmann spruce riparian
Engelmann spruce - subalpine fir dry forested
Engelmann spruce - subalpine fir dry parkland
Engelmann spruce - subalpine fir wet forested
Engelmann spruce - subalpine fir wet parkland
Garry oak - arbutus
Interior Douglas-fir
Interior western hemlock - Douglas-fir
Interior western hemlock - subalpine fir
Interior western hemlock - western redcedar
Interior western redcedar - grand fir
Lodgepole pile
Lodgepole pine outcrop
Mountain hemlock - amabilis fir
Mountain hemlock forested
Mountain hemlock parkland
Ponderosa pine
Sitka spruce - black cottonwood riparian
Spruce - Douglas-fir
Spruce - skunk cabbage swamp
Subalpine fir - scrub birch forested
Subalpine fir - scrub birch krummholz
Subboreal white spruce - lodgepole pine
Subboreal white spruce - trembling aspen
Trembling aspen copse
Western hemlock - paper birch
Western hemlock - Sitka spruce
Western redcedar - black cottonwood riparian
Western redcedar - paper birch
Western redcedar swamp
Whitebark pine parkland
White spruce - balsam poplar riparian
White spruce - black cottonwood riparian
White spruce - paper birch
White spruce - subalpine fir

Non-forested Habitat Classes (40)

Alpine grassland
Alpine heath
Alpine meadow
Alpine tundra
Alpine unvegetated
Alpine shrubland
Avalanche track
Big sagebrush shrub/grassland
Bunchgrass grassland
Cultivated field
Estuary
Fast perennial stream
Glacier
Intermittent stream
Intertidal marine
Large lake
Marsh
Meadow
Montane shrub/grassland
Orchard/vineyard
Reclaimed mine
Reservoir
Rock
Sedge fen
Shallow open water
Shrubcarr
Shrub fen
Shrub swamp
Slow perennial stream
Small lake
Sphagnum bog
Subalpine grassland
Subalpine meadow
Subalpine shrub/grassland
Subtidal marine
Talus
Tamarack fen
Transmission corridor
Transportation corridor
Urban

guidelines require that habitat management objectives be identified at the local level. This requires a description of habitat and identification of wildlife species with emphasis on the red-, blue- and yellow-listed species within each habitat class, within each biogeoclimatic subzone or variant.

Information already in the regional wildlife plans provides a good start. In these plans ecoregions, biogeoclimatic zones and habitat classes provide the framework or building blocks to capture biodiversity and set local level objectives. Guidelines would require a refinement to extend these objectives to an operational level. The setting of management objectives at an operational level needs to be completed before any guidelines can be developed. An example of a framework for identifying habitat management objectives is shown below.

Nechako Lowland Ecoregion (the area near Prince George)
Wet Cool Central Subboreal Spruce Subzone (SBSwk)

Habitat Class	Habitat description	Habitat objectives	Wildlife/forestry guidelines
Engelmann spruce - subalpine fir habitat class	good browse potential (site associations and forest cover types)	**moose**, maintain forage, snow interception **furbearers**, coarse woody debris **woodpeckers, owls, and small mammals**, woody debris, wildlife trees	1. planning 2. roads (access) 3. harvesting 4. silviculture

This ecological approach would describe the biodiversity and enable the identification of habitat management objectives that are linked to the red-, blue- and yellow-listed species in the regional plans. The list of habitats and species requirements will be long, but once captured the information could be distilled. Each region would have to provide greater detail than presently has been summarized in the regional wildlife plans. The Wildlife Program has much work to do in preparing operational habitat management objectives in order to participate in a consensus approach for wildlife/forestry guidelines.

The types of items that would be addressed by the guidelines would be cutblock size, amounts of coarse woody debris, numbers of wildlife trees, timing of harvests,

road building, access management, herbicide use, silvicultural and harvesting systems. This would be done with input from the forest industry and MOF.

WHO PAYS

There are four different costs foreseen: 1) the cost of developing the management objectives, 2) the cost of the guideline process with meetings and staff involvement, 3) implementation costs, such as training and the altered forestry costs, and 4) monitoring costs after implementation where guidelines are tested to see if they are working and whether the goals are being met.

The Wildlife Branch presently has assigned staff to the steering committee and identified guidelines as a function for one staff member. No funds have yet been allocated. Regional involvement is necessary and this requires either additional staff or funds to participate in setting management objectives. The Wildlife Program can get the objectives completed if this is made a high priority and only then can the discussion with all cooperating parties take place.

Funding the process to get the participants together will likely be shared among the stake holders.

Implementation will require training. The costs associated with higher operating costs, caused by additional constraints or planning, will need to be recorded. The true cost of these guidelines can be determined over a trial period. The forest industry may have to absorb any of the initial operating costs.

The costs of monitoring how successful the guidelines are in achieving the objectives will have to be undertaken by the government and used in the reassessment of the guidelines.

The biggest uncalculated cost may be to the wildlife resource and the diversity of species and habitats that will exist at the end of the next forest rotation. What will it be like with and without wildlife/forestry guidelines? We can truly improve our operational management of habitat, and leave intact enough of the pieces of the biological legacy that presently exists, to sustain the biological diversity of the forests and meet our needs for timber.

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HOW MODELS CAN HELP FOREST AND WILDLIFE MANAGERS

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ABSTRACT

Models of interactions between wildlife and forest management could be used more effectively in British Columbia to help integrate the production of timber and wildlife. This paper describes the purposes and types of forestry-wildlife models, provides examples used by land managers during the last ten years, discusses the advantages of using models in resource management, points out several issues in central British Columbia to which modeling could be applied, and suggests some simple guidelines for managers to follow in selecting and using models.

INTRODUCTION

The topic of this paper is how models can help managers who are trying to integrate the production of wood and wildlife. I am not a modeller by profession, so I will not discuss details of building models and testing them. I am most interested in how we in the British Columbia Forest Service and others in government and industry could make better use of models in helping us with the truly formidable challenge of producing the right mix of timber and wildlife for the citizens of our province. Most managers, in my experience, want to know how to use a tool (in this case, a model) to solve problems, not the details of how the tool was designed and built.

A certain amount of background on modeling is unavoidable as an introduction. Most resource managers are familiar with some single-resource models, such as MUSYC for timber-yield modeling and ONEPOP for wildlife populations. This paper addresses models that are specifically designed to consider the interactions between trees or habitat and animals. It begins with a short discussion of the purposes and types of forestry-wildlife models and gives a few examples of models in use now or recently. Most of the paper focusses on the advantages of using models in resource management in British Columbia and on potential applications to important local issues. It closes with some simple guidelines on how managers can make models work for them.

First, we need to be sure we all picture the same thing when I use the term model. Many definitions are available, but Stormer and Johnson's (1986) is one of the simplest and clearest. They said (p. 159) that models are "... quantitative abstractions of the essential parts of real-world situations". That pretty well says it all: a forestry-wildlife model is someone's idea of how part of the real world works, expressed in numerical terms. Note that it isn't necessary for it to be a computer or simulation model; it can be much simpler. For example, figure 1 illustrates one of the most common types of forestry-wildlife models, a Habitat Suitability Index (HSI) model built

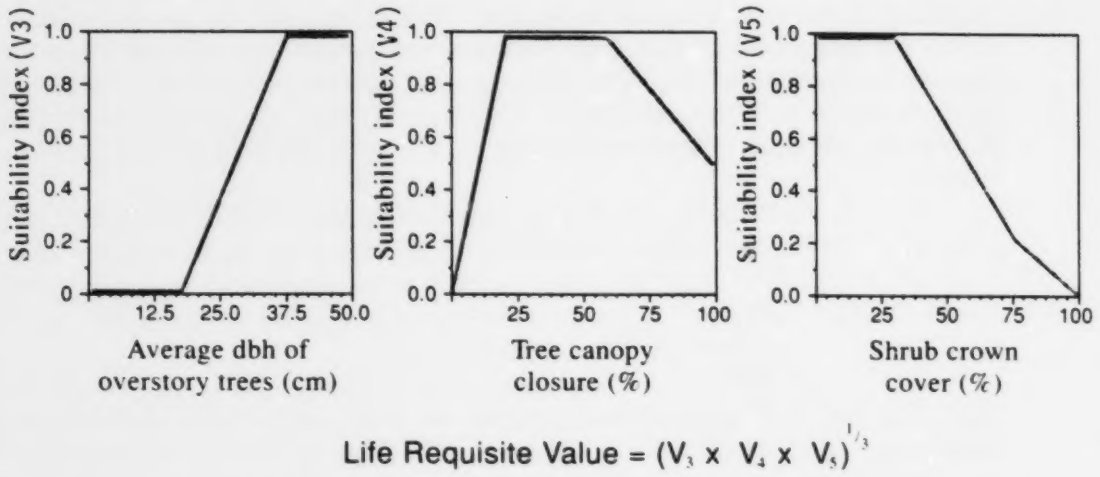

Figure 1. Habitat Suitability Index model for fox squirrel (Sciurus niger) cover and reproductive habitat in the eastern United States (Allen 1982).

for the U.S. Fish and Wildlife Service.

That's what a model is. What are such models used for? With thanks to Bunnell (1989), Marcot (1986) and others who've written on this subject recently, I'm going to suggest there are only 3 purposes for forestry-wildlife models: to further understanding, to predict responses or trends, and to communicate knowledge.

TYPES OF MODELS

Let's consider first models that are used to further our understanding of how a particular forest-wildlife system operates. This is usually only a researcher's goal. Often the researcher doesn't care how well the overall model predicts the future, as long as it illustrates where more knowledge is needed to make the model better. As Bunnell (1973, p. 170) said of such "research" models "As long as your model is wrong you continue to learn something. Once it fits the data you do not know what to believe."

A model built for the Integrated Wildlife-Intensive Forestry Research (IWIFR) program in its earliest stages (McNamee et al. 1981) is a good example of one intended only to help improve understanding of an ecosystem (figure 2). In this case it was to direct the IWIFR program to key research topics on deer, elk, and forestry relations on the southern British Columbia coast.

That is not the kind of model most land managers want. They want the second type: the kind that can accurately predict the future state of the system they are managing. Such models are one means of assessing whether the manager will be able to meet his or her resource objectives. A typical question that such a predictive model might address is "What if I do something to the habitat--log five 40-ha clear-cuts over six years, for example--what wildlife impacts would that have?" The most important feature of this type of model is that it needs to be valid, that is, it must fit the user's needs and provide reasonably accurate predictions of what really will happen.

The HSI model discussed previously is a good example of a predictive model. It represents what biologists in the eastern United States think is important about fox squirrel nesting and cover in the form of 3 line graphs and a simple equation. In this type of model, the accuracy of the predicted index of habitat value is far more important than any understanding of the ecosystem's functional relations. Often researchers do not like such models, because their builders must go out on some shaky biological limbs. For example, why should the habitat variables for fox squirrel nesting necessarily be equally weighted in calculating the overall habitat index, as they are in the formula in figure 1? Nevertheless, managers have to make decisions. They are often happy to use the best model available, even if its authors tear their hair and rend their garments over the inappropriateness of using it for such a purpose.

Third, and finally, some models are used for communicating knowledge. Many models provide neat, simple summaries of the most important interactions between forestry practices and habitat values. The key to the use of models for transferring knowledge is the way their quantitative aspects are expressed. So-called "word models" and line graphs are probably the best formats. A simple model of the relation

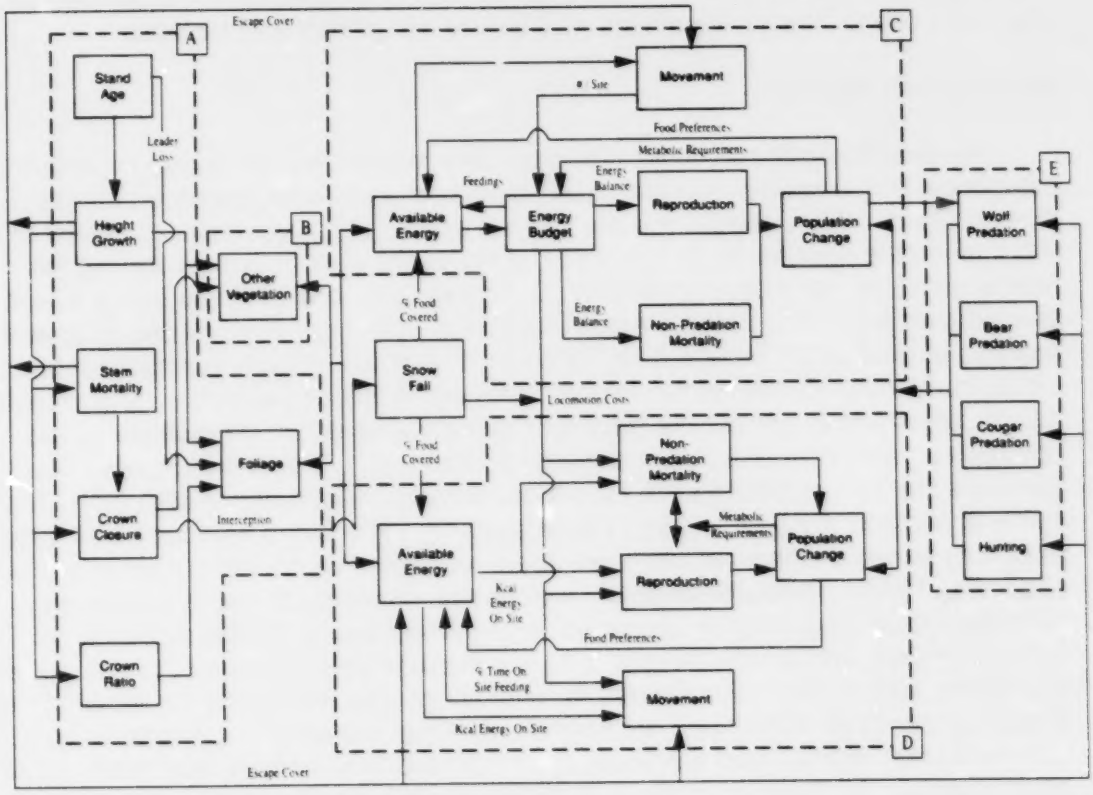

Figure 2. A conceptual model of black-tailed deer (Odocileus hemionus columbianus) and Roosevelt elk (Cervus elaphus roosevelti) ecology in the forests of Vancouver Island (McNamee et al. 1981).

between the abundance of one type of deer forage and forest overstories could be expressed in a graph like figure 3, or in words as "Salal (Gaultheria shallon) leaf production is about 70 g/m^2 at 35% forest canopy closure, declines to about 20 g/m^2 at 60% closure, and is negligible when canopy closure is 90% or more.

Models for both understanding and communicating can certainly help resource managers, but most will find predictive models of greatest interest. At this point I will leave the other types, then, and focus the rest of my discussion on those models that one might use to predict the effects of land use on species and habitats.

PREDICTIVE MODELS

For simplifying the discussion of predictive models, we can group them in three categories: single-species models, multi-species models, and resource-analysis models (Berry 1986). Single-species models predict the populations or habitat of only a single wildlife species, such as moose. One might want to assess the overall habitat suitability for moose in watershed, for example, and evaluate how it would change over time. The Habitat Assessment and Planning (HAP) model for spatial analysis of deer or elk habitat (Eng 1990) is an example of such a single-species model currently under development for managers in British Columbia. Multi-species models allow one to assess the effects of forest management on multiple animal species that are often grouped into guilds or life-forms. The United States Forest Service's life-form system for the Blue Mountains of Oregon and Washington (Thomas 1979) is perhaps the best known of such systems. The same approach was used in analyzing potential effects of intensive forest management on Vancouver Island wildlife (Sadoway 1988). Resource-analysis models are intended for use in evaluating multiple outputs (e.g., timber harvested, employment levels, wildlife populations, recreation user-days) under several different management scenarios. Such models are widely used in the United States for evaluating long-term plans for National Forest lands (Verner et al. 1986); and occasional examples are seen in Canada, including one for timber, moose, and scenic beauty in Ontario (Tak and Benson 1989). The AFIRM system for forest planning in British Columbia (Dellert 1990) will probably lead to the development of such models for our forests.

Now let's consider what models can do for you as resource managers. Why should you consider using them in integrated management of timber and wildlife? One obvious advantage is that models are easily computerized, allowing rapid computation of the complicated formulas that are often needed for predicting habitat values, timber production, and other outputs. Second, with the advent of Geographic Information Systems (GIS) and simulations of vegetative succession, models of spatial relationships can deal with long-term habitat trends over areas much larger than forest and wildlife planners have ever before been able to effectively address. For example, watersheds of 1,000 or even 20,000 hectares are not too large for evaluations of food and cover interspersion, by stand, using such models (Eng 1990). This promises a much more comprehensive and forward-thinking approach to forestry-wildlife planning that we could ever manage before. A third advantage of building predictive models is

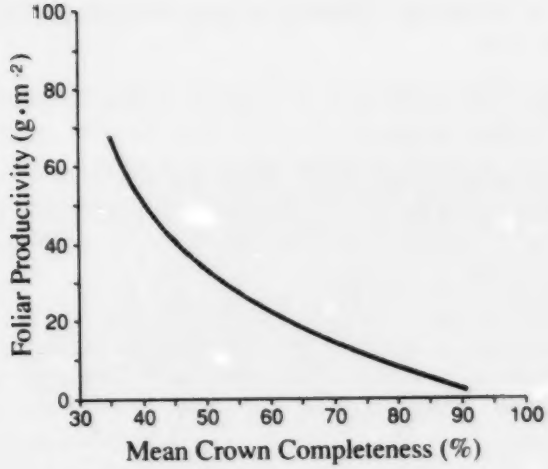

Figure 3. The relationship of foliar productivity of salal to crown completeness in immature forests on Vancouvuer Island (adapted from Vales, 1986, Fiure 2.3).

that it forces us to filter out all the extraneous information about forestry-wildlife relations that sometimes leads us to "paralysis by analysis". The rigor imposed on us by the need to quantitatively express our knowledge of complex natural systems is a great simplifying agent. Most people are not inclined to build in anything more than is absolutely necessary when every function has to be expressed as a mathematical formula. Fourth, predictive models are especially useful for "gaming", that is, trying alternative land management scenarios on for size by using the model to check out how well the expected results would meet resource objectives. This application is likely to become more important to many of us in government agencies as the public demands more justification for the programs we choose to implement. Fifth, and finally, models allow us to explore potential results of our actions when we don't have real-world data to guide us. Models of global climate change are the best current examples of this use.

APPLICATIONS

Given these advantages then, what are some of the specific applications in central British Columbia for which modeling is potentially useful? I think one of the most important is in deciding how we are going to maintain wildlife diversity in our forests. Maintenance of diversity is one of the major goals of the Ministry of Environment, and I expect that the Forest Service and the forest companies are soon going to be pressured to make it an objective for public forest land. There are over 600 species of wildlife in British Columbia, with probably 500 or so using forests at one time or another. How else are we going to deal with this enormous number of animals if not through multi-species models running in local offices? The southern interior habitat handbook (Harcombe 1990) was our first attempt at such a system. If public concern over the environmental effects of forest practices continues to mushroom, we may have to produce a lot more of these diversity models much sooner than most of us expected.

A second application is in planning for the habitats of wildlife, especially featured game animals and threatened or endangered species, over large areas and long time frames--perhaps 20 years, perhaps the whole rotation period. We have struggled by in the past by looking at changes in one or a few stands over 3- to 5-year planning horizons, but we have the GIS technology now in some forest district offices (and we'll soon have it in many) to bring wildlife habitat projections up on a level with long-term timber yield modeling. Twenty year plans and "total-chance" plans are being used more often for long-term timber development planning, and wildlife habitat analysis needs to keep pace.

Last, but certainly not least, we can do much better at resource-analysis modeling. I think one of the prime examples is in the development and analysis of options for Timber Supply Areas (TSA's). In most TSA's at present, only one or two wildlife options are considered in evaluating the land base from which the sustainable yield is calculated. Those options are formulated only as constraints on the land base available for timber production, based on maps of wildlife habitat provided by the

Ministry of Environment. The wildlife options may be accepted or rejected by the TSA Steering Committee, leading to an all-or-nothing result for wildlife. If the Steering Committee was to ask, however, "What would be the effect on wildlife of withdrawing only 70% of these areas, but distributing them over all of the best winter ranges?", no one can provide a quick answer defendable on technical grounds. This puts the wildlife resource at a serious disadvantage in planning the future of our forests. Integrated resource managers need to demand that good models for analyzing timber and wildlife production be developed so that the two resources can be considered equitably. TSA resource-analysis models for forestry and wildlife designed for that purpose would be a good start.

CONCLUSIONS

That's how I believe we could make better use of models than we do now. I'm going to close with some suggestions on how to be sure you're getting a good model when you do decide to use one. There are some serious dangers in uncritically applying any available model that appears to have the right types of outputs. Jack Ward Thomas (1986, p. xxi) made this point well when he said "Blind acceptance of modeling results from the bowels of the computer can be as irrational as reliance on the honored and ancient skills used by the oracles in deciphering messages in the entrails of a chicken." Several authors have discussed at length the proper use of predictive models (Bunnell 1989, Goodall 1989, Hurley 1986, Marcot 1986, Salwasser 1986, Thomas 1986). I have chosen to emphasize the following four points.

The best way to be sure you know what the model can and can't do, and when it can be trusted, is to work with the researchers who are building it for you. In other words, make sure it is a team effort, and that the eventual users (the managers) are in on the development process right from the start.

You should also make sure that the model builders provide clear and complete documentation. They should explain the strengths and weaknesses of the model, the geographic area it applies to, the assumptions that went into it, the kinds of data needed to run it, correct and fallacious interpretations of output, the levels of confidence that can be placed in its predictions, and any other information you need to allow you to apply it confidently. This back-up documentation is at least as important as graphs or tables of outputs, but it is often missing from published models.

You should make sure the model is built to be practical. This could include many factors, but two of the most important are that it should run on data that is already on hand or is easily collected, and that it requires only equipment (computers, for example) that are already installed or can feasibly be acquired. It is all too easy for a non-manager to build a model that requires detailed habitat data that you can't afford to collect and a mainframe computer that you will never have in your office.

And you should ensure that any model used in management is validated, that is, its predictions are compared against results in the real world and it is revised if it doesn't work well. Any model can produce predictions, but will they always be good predictions? Certainly not. Resource managers are in the powerful position of being

able to use adaptive management (Holling 1978) to test our ideas of forestry-wildlife relations through land management programs applied on the ground. By monitoring the results and adapting your models and management methods, you can probably improve timber-wildlife integration five times as fast as if you waited for researchers to conduct controlled experiments on every practice.

That is all I have time to cover. This has been a very brief review of a complex subject, so if you expect to make use of models in management decision-making I encourage you to read some of the papers I have referred to. The topic of making proper use of models is one that deserves particular attention.

In closing, I would like to emphasize that as life gets more complicated for all resource managers, we will have no choice but to make better and more frequent use of models. They are powerful tools. Let's make sure we use them well.

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USING GEOGRAPHIC INFORMATION SYSTEMS TO ASSIST WITH THE INTEGRATED MANAGEMENT OF FORESTRY AND WILDLIFE HABITAT

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ABSTRACT

Forestry activities have substantial impacts on wildlife habitat, but there are few analytical tools to assist with the assessment of those impacts. Planning for wildlife habitat needs is a difficult task because many wildlife species move among forest stands to obtain resources. Therefore, wildlife managers must include the need for diversity of habitats over large (watershed-sized) areas in their planning. The development of geographic information systems (GIS) has made it possible to build analytical tools that explicitly incorporate the spatial aspects of wildlife habitat requirements into habitat plans.

The Habitat Assessment and Planning (HAP) tool, described here, is one such analytical tool that is currently under development as part of a cooperative project between the B.C. Ministries of Environment and Forests. An example of the way in which the tool can assist in making decisions about habitat management needs is given for the winter habitat of black-tailed deer.

INTRODUCTION

Habitat management is commonly used to achieve wildlife population objectives. However, wildlife managers frequently do not have control over the timing and placement of habitat manipulations that indirectly result from extensive forestry. Foresters have control but are often not aware of the effects of forestry on wildlife habitat. The resulting lack of integrated planning has often led to conflict. The Habitat Assessment and Planning (HAP) tool was developed specifically to aid in resolving one such conflict; the fate of old-growth forest stands that are deferred from harvesting because they are winter range for black-tailed deer (Odocoileus hemionus columbianus) and Roosevelt Elk (Cervus elaphus roosevelti). However, we believe that the HAP tool has general applicability to many wildlife species throughout British Columbia.

Timber development and habitat management often occur at very different "operational" planning horizons. Wildlife managers should plan over time frames of at least 20 years and base their activities on both stands and watersheds. Timber managers treat stands or small groups of stands independently. The differences in spatial scale occur because animals must move to obtain resources and trees do not.

Consequently area-based planning is less difficult for forestry than it is for wildlife. The Habitat Assessment and Planning (HAP) tool assists in the integration of planning for these two values.

INSTITUTIONAL FRAMEWORK

Initial development of the HAP tool has concentrated on the task of responding to 5 year "operational" forestry plans submitted by the companies to the Ministry of Environment for review and approval. Habitat Protection Biologists and Technicians from Ministry of Environment review the 5 year plans and suggest changes to the areas and scheduling of cutting to reduce the impact on wildlife habitat. This task is extremely complex and requires a good understanding of species habitat requirements, forest successional patterns and knowledge of local conditions. The current procedure is restricted in spatial and temporal scope yet it is time consuming and assessments of impacts on wildlife habitat are subjective.

Use of GIS and the HAP tool will help alleviate these problems by:

1. automating many of the manual aspects of the tasks;

2. identifying a small subset of the total area where site specific knowledge is critical; and

3. reducing the spatial and temporal complexity by modelling habitat quality.

CONCEPTUAL FRAMEWORK

The HAP tool has been designed as a mechanism that provides information to managers which they can use to make decisions. The tool itself will not make decisions. Decision making by managers will enable adaptive management procedures (Walters 1986) to be included in the process of habitat management.

In developing the HAP tool we have used the simplest models that provided useful results. An expert specifies those aspects of the system which he believes are important to the management goal. This approach makes development, application and validation of the models easier and it allows managers to easily understand, and therefore believe in, the system (Bunnell 1989).

"Game abundance should increase in situations where various types of food and over come together" (Leopold 1933). This concept is the core of the HAP tool. Previous attempts to incorporate habitat interspersion into wildlife planning, through the use of "interspersion indices" (e.g. Hienen and Cross 1983), were not adequate because they "added up" interspersion and did not represent the relationship among individual habitat polygons (stands). Adequate representation of spatial interspersion is possible only by processing habitat data while retaining its spatial integrity. This is only feasible through computerized map analysis (GIS).

DESCRIPTION OF THE HABITAT ASSESSMENT AND PLANNING (HAP) TOOL

The HAP tool is a series of micro-computer based models that allow forestry and wildlife managers to incorporate the spatial and temporal aspects of wildlife habitat into operational forestry plans and habitat plans. The HAP tool helps managers to:

1. assess wildlife habitat suitability and forestry impacts;

2. develop plans that minimize negative impacts and increase the benefit of forestry to wildlife habitat;

3. identify data gaps and the risk of uncertain management actions;

4. assess priorities for habitat management projects; and

5. document the rationale used to make decisions that affect wildlife habitat.

The HAP tool consists of 3 component parts:

1. a regional priorities model;

2. a watershed asssessment model; and

3. a management options model.

Each model has linked inputs and outputs that operate in an integrated and iterative fashion (figure 1). The regional priorities model is used to prioritize planning units (watersheds) in terms of the need for habitat management (McNay et al. 1987).

The watershed assessment model is then applied to each high priority planning unit. Watershed assessment is a stepwise and iterative process. In the initial step current habitat suitability, for a wildlife species, is assessed. Proposed forest harvesting scenarios are overlaid on the existing conditions and changes in vegetation through time are determined. The resulting habitat suitability under each scenario is compared with agency objectives. Input to the model includes large scale GIS data and proposed forestry plans. Model outputs are of 4 types:

1. Data gaps: stands where available data are not sufficient for a reliable assessment.

2. Sensitive Stands: stands where large changes in habitat suitability may result.

3. Future Forecasts: changes in habitat suitability through time.

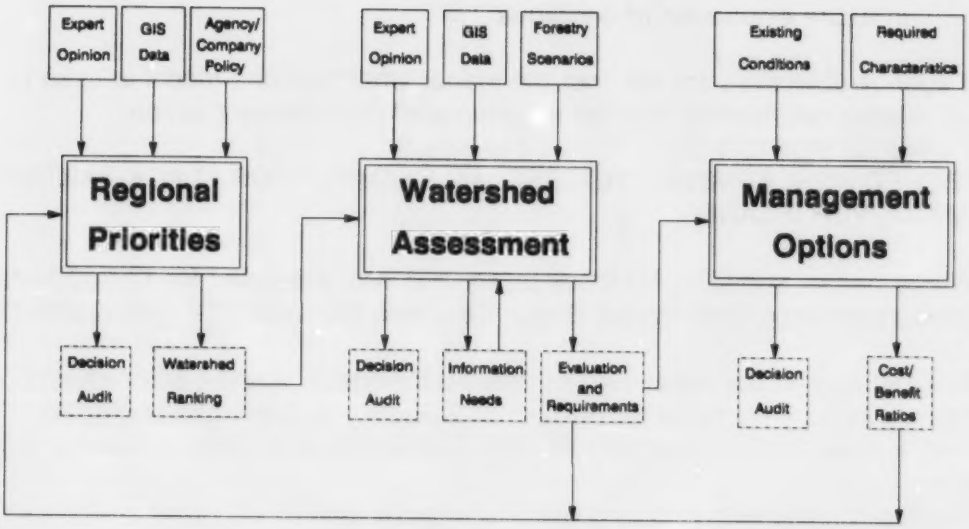

Figure 1. Framework for the Habitat Assessment and Planning tool.

4. Documentation: records of the results of the watershed assessment to aid in future evaluation of decisions.

If agency objectives are not met the management options model is used to obtain a relative cost/benefit ratio for the proposed management action.

WATERSHED ASSESSMENT PROCESS: AN EXAMPLE FOR BLACK-TAILED DEER ON VANCOUVER ISLAND

Winter habitat suitability for black-tailed deer was assessed for 11 000 hectares on southeastern Vancouver Island, British Columbia (described by McNay and Doyle 1987).

The first step in the watershed assessment process, evaluation of current habitat suitability, requires a model of winter habitat suitability for black-tailed deer as described in detail in Eng et al. (1989). The model (figure 2) is based on the following premises.

Snowfall on Vancouver Island exhibits a cyclic pattern with severe winters re-occurring at approximately 18 year intervals (Page 1990.) Therefore, for long-term population viability, black-tailed deer require access to habitat that will enable them to survive both mild and severe winters. We have found that accessability of severe winter habitat is influenced by the migratory behaviours of individual deer. Deer exhibit three different migratory behaviours. Obligate migrators (individuals that move at the same time of year regardless of weather conditions) will spend the winter on severe winter habitat (i.e. for those deer severe winter habitat must be adjacent to mild winter habitat). Year-round residents (individuals that do not migrate) will move up to 0.75 km from mild winter habitat to severe winter habitat. Facultative migrators (individuals that move from summer to winter range depending on day-to-day changes in weather conditions) will move up to 3.0 km from mild winter habitat to severe winter habitat (McNay and Doyle 1987).

Within a single day deer require food and cover (primarily stands that intercept snow thus maintaining the availability of forage). The quality of habitat increases as the distance between these two attributes decreases. The habitat quality of a given location is also constrained by its aspect and elevation. High elevation north facing slopes tend to receive more snow and retain it longer (i.e. lower quality) than do low elevation south facing slopes (i.e. higher quality). The suitability of a given location differs between years because deer require better snow interception cover during a severe winter than during a mild winter and deer movements are more constrained by deep snow during a severe winter.

Current vegetation cover was classified using the methods described by Klinka et al. (1984). Each plant association and successional stage was rated from 0.0 to 1.0 for its ability to provide forage and snow interception cover. Combined aspect and elevation classes were also rated from 0.0 to 1.0 in terms of the constraints they placed on the ability of current vegetation cover to provide deer habitat. Ratings were based on judgements of field biologists familiar with black-tailed deer in the area.

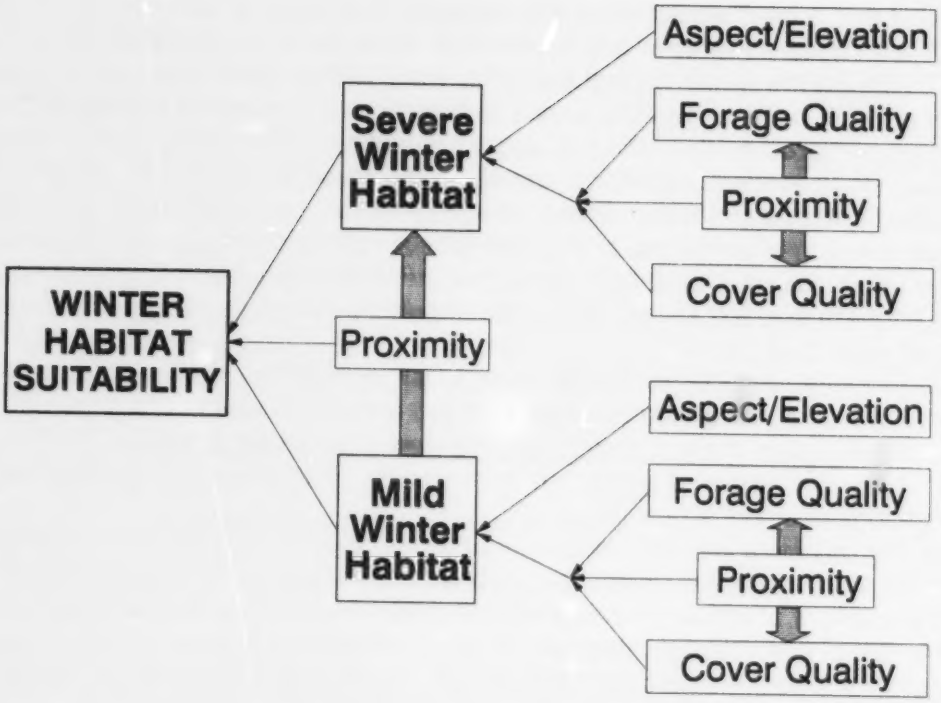

Figure 2. Winter habitat suitability model for black-tailed deer.

Distance buffers from high quality forage and high quality mild winter and severe winter cover were calculated. The distance buffers were rated in terms of the likelihood that a deer would move that distance in shallow or deep snow. In severe winters with deep snow deer are reluctant to move out of cover (figure 3).

To create the winter habitat suitability map, ratings for forage quality, cover quality and the distance buffers were combined using a complex averaging procedure and then multiplied by the rating for aspect-elevation. Each polygon was categorized as adequate or inadequate habitat based on the resulting value (inadequate <0.5< adequate). Map layers representing adequate severe and mild winter habitat were overlaid creating a composite winter habitat suitability map (figure 4). Distance buffers around adequate severe winter habitat that included adequate mild winter habitat within 0.75 km and 3.0 km represent the migratory behaviour types of black-tailed deer, as described above.

A proposed habitat manipulation, in which most of the remaining low elevation old growth would be harvested between 1990 and 2010, was then assessed. The successional stage of each stand was changed to simulate conditions at the year 2020. A reassessment of winter habitat suitability in 2020 was conducted using the methodology outlined above (figure 5).

If the objective was to maintain the current quantity and distribution of winter habitat at 2020, then this objective would clearly not be met (compare figures 4 and 5). The amount of adequate severe winter habitat will not decrease substantially from 1990 to 2020, even though most of the low elevation old growth will be harvested, because the model predicts that new severe habitat will develop at the edges between old second growth (which provide cover) and younger stands (which provide food). However, the amount of inadequate habitat will increase from 49.2% to 64.0% of the assessment area during the planning period and the amount of habitat suitable for supporting facultative migrators will decrease substantially. Deer winter habitat will be severely fragmented, particularly in the western portion of the assessment area.

OPPORTUNITIES AND CONSTRAINTS

The use of geographic information systems offers significant advantages over analog maps in the assessment and planning of wildlife habitat because daily and seasonal habitat interspersion requirements can be realistically modelled. Iterative assessments, comparing different scenarios, can be accomplished with minimal effort. The resulting output can be used to develop recommendations for changes to habitat manipulation scenarios and habitat enhancement programs.

However, there are several difficulties with the widespread application of this technology. Suitable models for management purposes (notably forest succession models) may be lacking and data may not be sufficiently detailed or reliable (current vegetation cover information). However, the most important difficulties relate to corporate and institutional attitudes:

1. effective use of the technology requires that wildlife managers explicitly

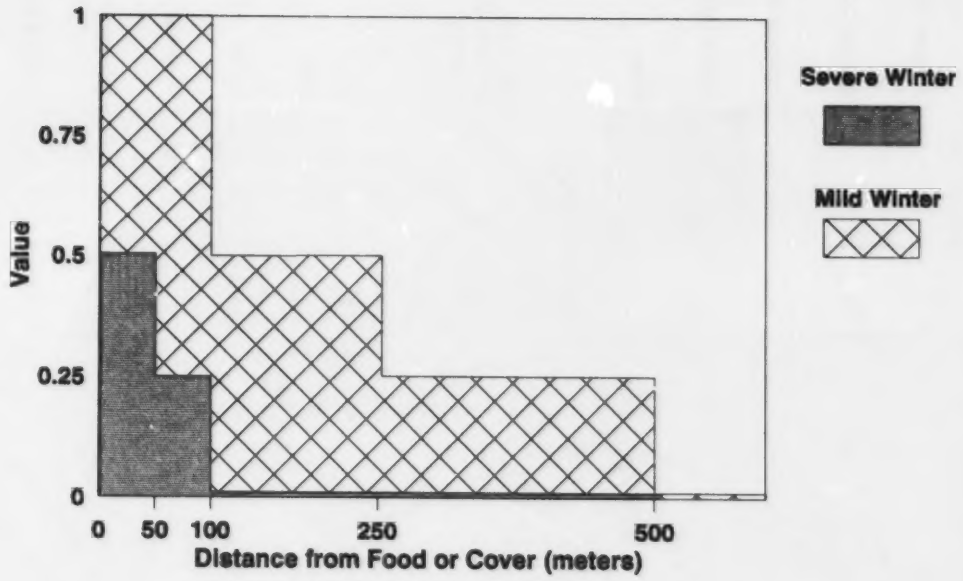

Figure 3. Model ratings for distance from food and cover during mild and severe winters.

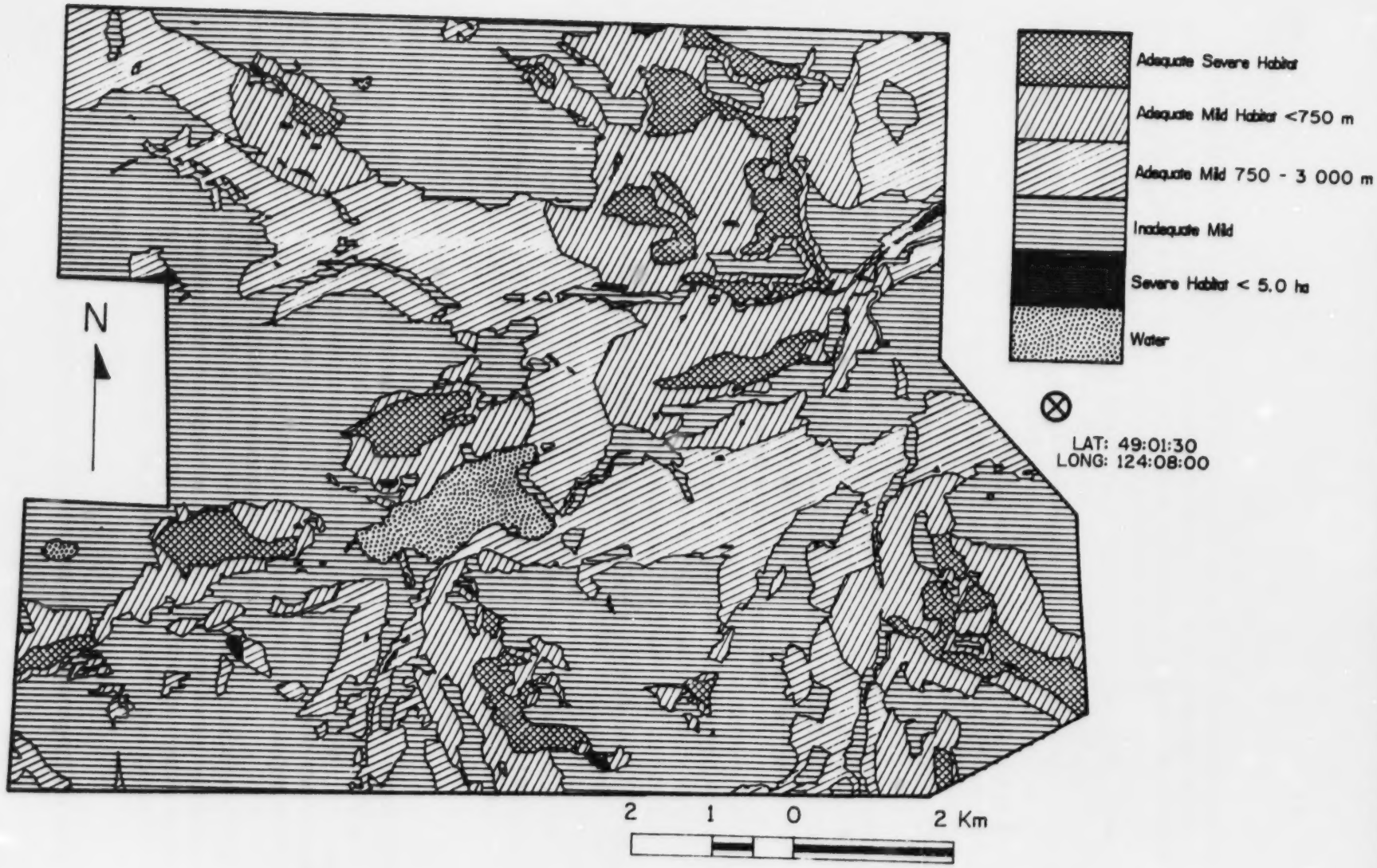

Figure 4. Projected winter habitat suitability map of the study area in 1990.

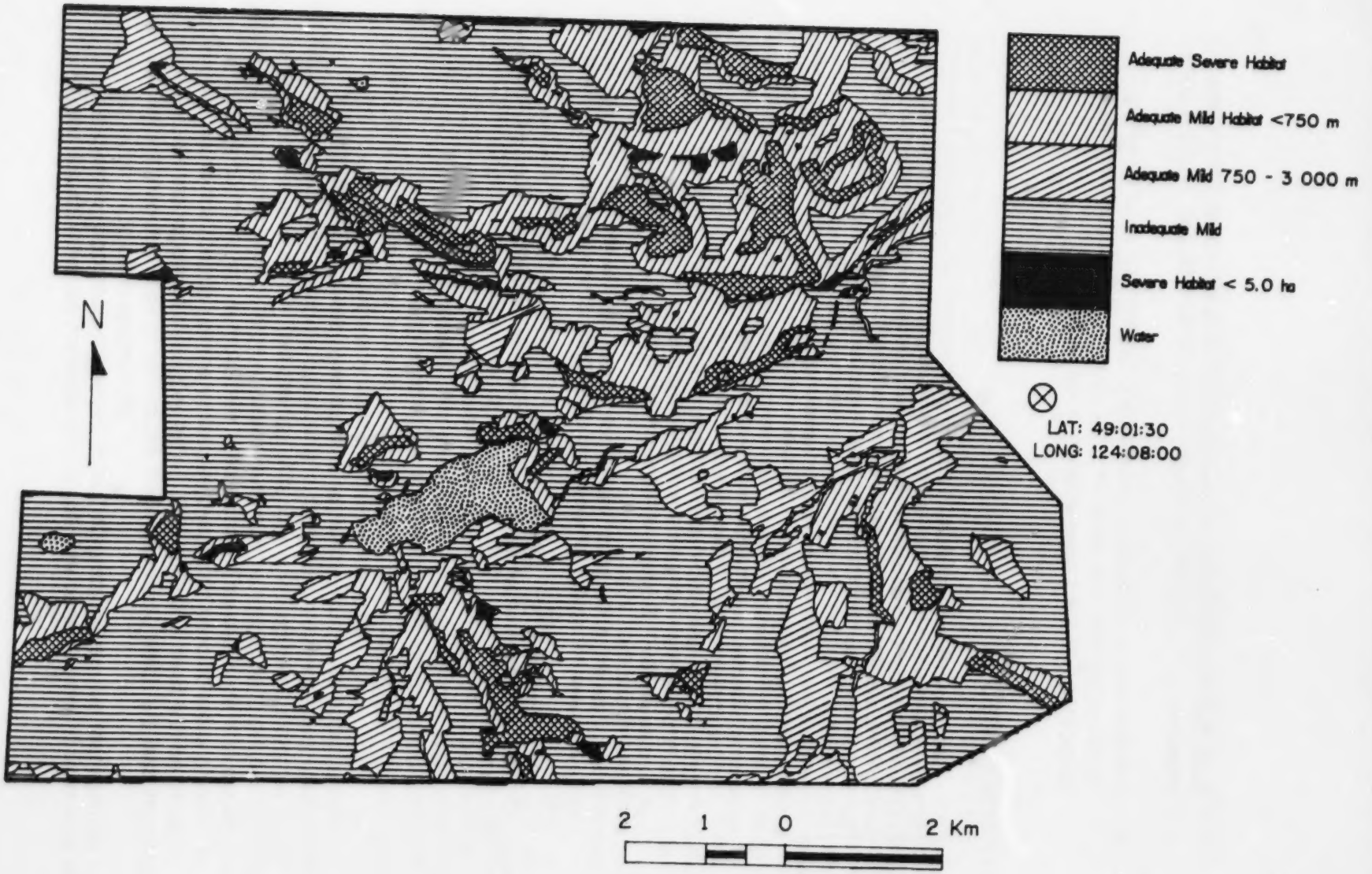

Figure 5. Composite winter habitat suitability map of the study area in 2020.

state their habitat objectives and develop methods of comparing those objectives to the objectives of other resource sectors; and

2. management at all levels of industry and government must be willing to accept the cost and short term reduction in staff productivity that will be associated with the implementation of the technology.

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A CASE HISTORY OF SUCCESSFUL INTEGRATED RENEWABLE RESOURCE MANAGEMENT PLANNING IN THE EAST KOOTENAYS.

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ABSTRACT

The Trench Plan is a strategic plan for the management of various renewable resources in the East Kootenay Rocky Mountain Trench. The Trench Plan area was divided into management polygons based upon the biophysical capability for various resources. For each of these management polygons, the primary resource uses were defined, an average percent forest cover was prescribed consistent with those primary resources uses, and basic resource values and management considerations were listed. Thus, the Trench Plan is an area-specific compilation of management strategies for Crown Land within the east Kootenay Rocky Mountain Trench area. The interagency planning process involving three provincial government ministries (Ministry of Forests, Ministry of Environment, and Ministry of Agriculture and Food) is described, as is the application of the plan.

The Trench Plan area falls within both the Invermere and Cranbrook Forest Districts. The actual Trench Integrated Renewable Resource Management Plan (Trench Plan) for the Cranbrook Forest District alone is a 200+ page document containing information and strategies for over 350 "management polygons" (geographical units) with associated color theme maps.

INTRODUCTION

The East Kootenay is endowed with abundant natural resources -- forests, forage (grasslands) and wildlife habitat, agriculture, and minerals. The first four are considered "renewable" since they can be reproduced (renewed) over time. However, managing to maximize any one of these resources has a resultant impact on the production of the other resources. For example, prescribed fire can improve forage production by removing young seedlings that compete with forage for sunlight and nutrients (forage values are increased while timber values are compromised). Similar examples could be cited for many combinations of resources.

This relationship between two or more resource values has posed significant challenges to different resource users and to the government agencies charged with managing these resources. The overlap of resource values has sometimes led to conflict and confrontation. In most cases, land can be managed to support a number of resources but to do so, compromise is essential. The challenge is to decide the relative importance (priority) of the various resources on specific areas of land. To plan resource management strategies for an area of land, it must first be decided which natural resource uses or values are more important, which are less important, and how much trade-off is appropriate.

This planning approach is referred to as "Integrated Resource Management"- the planning of natural resource management to optimize benefits from all resources to

society - recognizing that compromise and trade-off is required.

Historically, the Southern Rocky Mountain Trench area has been difficult to manage on an integrated basis. This is due to its high value for wildlife winter range, grazing for domestic livestock, agriculture, timber, outdoor recreation and the competing needs of the various resource users. In the past, discussions between the different resource managers have been contentious. Debate sometimes focussed on different management philosophies or differences in personality, rather than on the biophysical capability of the land.

Another form of this discussion is what I call the Ologi'tist debate. This is where the Agrologist, the Biologist and Technologist would each insist they were right. Often they would call in other Ologists, such as Pedologist, Entomologists, Hydrologists and Pathologists to re-enforce their claims. If this didn't work the special interest groups would enter the fray.

Often the decision would have to be made by the local Forest Service District Manager. This often led to problems. Some may sound familiar to you. If so you may need a strategic plan.

THE TRENCH INTEGRATED RENEWABLE RESOURCE MANAGEMENT PLAN

The Trench Plan is a strategic plan for the management of various renewable resources in the Rocky Mountain Trench. The Trench Plan area was divided into management polygons based upon biophysical capability for varous resources. For each of these management polygons, the primary resource uses were defined, an average percent forest cover was prescribed consistent with those primary resource uses, and basic resource values and management considerations were listed. Thus, the Trench Plan is an area-specific compilation of management strategies for Crown Land within the east Kootenay Rocky Mountain Trench area. The interagency planning process involved three provincial government ministries: Ministry of Forests, Ministry of Environment, and Ministry of Agriculture and Food. The planning process was initiated to try to overcome the following problems:

- Missed opportunities for forest and forage ehancement due to length of time to crank a proposal through the system.

- Wasted time in having to set up a round table referral for every proposal. Concensus was often difficult to obtain because we lacked an overall strategy.

- Inadequate overview of all resources and capability to produce more grass, trees, etc.

- Lack of support from the public and users because we could not clearly show them where we were going.

- We needed a data base to refer public interest groups to as a demonstration that

progress is being made at managing the resources in the Trench.

- Difficulty in preparing development plans due to lack of long term goals and land use decisions.

THE PLANNING PROCESS

It became obvious that we needed an integrated renewable resource management plan and that this plan should be based on objective, biophysical, resource data. There were a number of existing operational plans, so imposing a strategy over top of them is a bit backwards. Therefore it was important to recognize traditional uses such as Christmas Tree Permits, Co-ordinated Resource Management Plans, Woodlots, Cutting Permits, etc.

In 1985 the two "Southern Trench" District Managers from Invermere and Cranbrook and the Regional Wildlife Biologist sat down and hammered out a basic framework for such a strategy.

We met with the 3 Regional Managers/Directors from Forests, Environment and Agriculture in November 1985 and obtained their support to embark upon what eventually became known as the Trench Interated Renewable Resource Management Plan. (TIRRMP) or simply the Trench Plan.

A Steering Committee was struck consisting of myself, the Regional Wildlife Biologist, the District Manager from Invermere and the Agrologist from the Ministry of Agriculture and Foods. The Ministry of Agriculture Rep has never attended the planning sessions but assure us they support the plan.

Our purpose was contained in a simple statement endorsed by the three Regional Managers/Directors.

> "To stratify Forestry, Wildlife and Range Management priorities for the Crown Land portion of the Southern Rocky Mountain Trench to assist in developing an integrated renewable resource management plan. Must be simple and expedient."

Not a very detailed term of reference and probably the reason there was a lot of confusion early in the game as to what we wanted, how we are going to achieve it and where the resources were going to come from. In hindsight this was probably a good thing because it allowed the people that were to be responsible or implementing the plan a say in how it should be put together. If you want reasonable assurance that any local plan is going to work you have to allow the users to develop it. This is not to say that upper echelon planners do not contribute. They are a good resource when the field staff run into snags. The two District Planning Officers were key players in putting the plan together as were the field staff and Resource Officers. As it turned out the process was neither simple nor expedient.

In 1986, the detailed planning began. A planning team was established, chaired

by the Forest Service District Planner, and included representatives from the planning, timber, range, recreation, wildlife, and agriculture departments of the involved Ministries.

At this stage we decided that we would concentrate on land capability before historic use. It quickly became evident that capability studies were out of the question so we began to look at Forestry Site index classifications because this information was readily available. The first set of maps we produced used a hand coloring scheme to show good sites as lst priority, poor sites as 2nd priority and low sites and open range as 3rd priority. Crown Range Priorities became the mirror image of this. i.e.: Priority 1 range was Priority 3 timber, etc. Wildlife habitat needs also fit in fairly well with this system because the mix of Wildlife species depends upon the maintenance of a mix of forest types and seral grassland/schrub stages.

It is therefore possible to develop a land use designation system which nearly maximizes the production of the more seral dependent species and the more mature forest dependent species with minimal losses of timber production from medium and good sites. I must emphasize though - that this is not a Wildlife priority system. It is based on ungulate habitat needs by dependency upon forest cover. A class one wildlife area would require 0-10% forest cover and 90-100% seral shrub/grassland - while class 3 for wildlife would require 50-100% forest cover and 0-50% seral shrub/grassland.

Incidently, most of the trench is rated as moderate to very high capability winter range for one or more wild ungulate species. Using the information gathered, the maps were compared and the Crown land in the Cranbrook portion of the Trench Plan was divided into approximately 380 management areas (referred to as"management polygons"). These polygons varied in size between 100 and 1800 hectares. The boundaries were then modified by local knowledge, physical features and structures, and occasionally administrative restrictions.

Once the above management polygons were identified, the planning team began to establish "primary resource uses" for each area. Once the "primary resource uses" were established for each "management polygon", the problem of expressing their relative prority and reflecting this in the management prescriptions had to be addressed. It was essential that measurement criteria be used which were relevant to all resources.

Many discussions were held on this subject before it was decided that the amount of forest cover would be the management prescription for each management polygon. It was agreed that, in general, forage for cattle and wildlife depended on the amount of sunlight which reached the ground. This in turn depended on the amount of forest cover. Other wildlife requirements, such as snow interception (thermal cover), hiding cover, and travel corridors, also depended on the degree to which an area was forested. Of course the timber resource is also dependent on the amount of forest cover.

An area with timber as a priority would be given a higher target forest cover than an area with grazing as a priority. Desired forest cover levels varied for wildlife, depending on the species and their requirements in an area. Generally, sheep and

mule deer prefer open country, elk prefer moderate cover, and whitetail deer prefer heavier forest. Integration of different resources were discussed, and compromises obtained, using a common frame of reference.

Primary Resource Uses (up to three per polygon) were established for each management polygon and listed in order of priority. A target average percent forest cover was assigned (eg. 35-70% or 0-10%) based on the relative priority of resource uses. A range in value was necessary to reflect the dynamic nature of the resources being managed (eg. a forest may be opened up by timber harvesting and will then fill in again until the next disturbance such as timber harvesting or fire again opens up the area). This data, plus additional information pertaining to specific polygons, were recorded in the Trench Plan.

Each management polygon also received a preliminary evaluation for the suitability of prescribed fire as a management tool. This was based on the primary resource uses and management objectives prescribed, local knowledge, and the inherent sensitivity of the site.

APPLICATIONS OF THE TRENCH PLAN

General Implementation

The Trench Plan identifies the primary resource uses, target percent forest cover, key resource values and concerns, and the types of general management prescriptions that are appropriate for each management polygon. This information is documented in a tabular format for ease of reference. By reaching interagency agreement on resource use priorities for each management polygon, along with target values for forest cover, conflict between different resource uses can be greatly reduced.

The Trench Plan will be used to:

1. provide broad integrated resource management direction for renewable resource management on each management polygon;

2. provide a framework for prioritizing resource management activities in the East Kootenay Rocky Mountain Trench (eg. heavily forested areas which have been targeted for lower forest cover values because of wildlife or cattle requirements should logically become a higher priority for timber harvesting);

3. provide a basis for evaluating other work proposals (eg. Canada Works Comfor, FEP, etc.) or give direction to proposals for habitat, range, or forest improvement projects within the Trench Plan area;

4. provide for a more efficient referral process that can concentrate on operational specifics (eg. concentrate on how a prescribed burn for forage

enhancement can be conducted safely rather than whether the area should be managed for forage or timber and whether or not the burn should be conducted) and thus result in improved efficiency.

5. can be used for budgeting.

It must be recognized that, in order to meet the broad management objectives of the Trench Plan, more detailed development plans will have to be prepared for those management polygons in which management activities are to occur. For example, the average percent forest cover prescribed may be met by:

1. having an even distribution of trees over the entire unit as a result of spacing or selective harvesting systems; or,

2. having a patchwork of open and forested areas; or,

3. by a combination of open and forested areas in conjunction with areas that have been spaced or selectively harvested.

These detailed plans will be done on a priority basis using the Co-ordinated Resource Management Planning (CRMP) process.

REVIEW

Minor updates to resource values and other site specific information for management polygons will be made on a continuous basis as new information becomes available.

Updates to the fundamental prescriptions, such as Primary Resource Use and the average percent forest cover, will be conducted on a periodic, as needed, basis. These updates will be made by reviewing the entire Trench Plan. Changes in one area may require change or compromise in other areas in order to maintain an overall balance between resource uses. The need for this type of review will be evaluated at least once a year.

The Trench Plan will become part of the "Status Quo" Option in the TSA Analysis for the next Cranbrook TSA Plan. Since the Trench plan area constitutes only 7% of the net land base for the TSA the potential impact of the Trench Plan on the Allowable Annual Cut is expected to be negligible. Benefits to other resource values from the Trench Plan are expected to be considerable.

We have presented the plan to the Licenced Resource Users, other Resource Managers, local Government and the general public with positive results.

Using their feedback to make changes where practical, we will then have the plan signed off by the three Ministries.

STRATEGIC AND OPERATIONAL LAND USE PLANNING IN THE EAST KOOTENAY TRENCH, BRITISH COLUMBIA

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ABSTRACT

Strategic planning in the form of the (East Kootenay) Trench Renewable Resource Integrated Management Plan (TRRIMP) followed operational planning in the form of Coordinated Resource Management Planning (CRMP) in southeastern British Columbia. Despite the successful implemention of CRMP's over most of the Crown land in the East Kootenay Trench, the absence of a land use strategy resulted in the renewal of former land and resource use debates. It is expected that the adoption of the TRRIMP land use strategy will lead to the re-establishment of cooperation between agencies and resource users and improvements in resource management. As well as providing functional land and resource plans for the East Kootenay Trench, the planning processes serve as an example for the remainder of the Province.

INTRODUCTION

British Columbia is a province which consists largely of rugged, mountainous terrain or high plateaus with a limited land area suitable for human settlement. Most of this province - fully 92.5 percent - is publicly owned Crown land which is administered by the provincial government. Thus, a single provincial government owns and controls a land area consisting of more than 216 million acres. However, less than five percent of this land base is situated in valley bottoms in the southern half of the Province and it is within these limited valleys that the numerous land use interests compete for land, resources and space.

The various provincial government agencies created to administer these public lands have conflicting mandates and the varous resource interests often individually seek to maximize returns from their resource-use activities at the expense of others. Several attempts to develop a provincial land use management strategy have not been successful.

The absence of any orderly approach to land use management has bred considerable conflict and controversy amongst user groups. The Rocky Mountain Trench of the East Kootenay region is a microcosm of land use problems found almost everywhere else in the Province. Government ministry initiatives to maximize wood fibre, livestock, wildlife and recreation all on the same acre all at the same time from land of variable capability has given the East Kootenay Region the reputation of being one of the most controversial if not hostile environments in which to practice forestry, operate a cattle ranch or to manage range or wildlife in the Province. Other government and private initiatives such as hydro electric reservoir, utility and

transportation corridor projects and urban, industrial and commercial recreational developments, most unplanned and often unilaterally imposed, have reduced the resource land base and heightened competition for remaining land and resources.

The uses made of the remaining public lands in the East Kootenay Trench - some 500,000 acres - are both varied and intensive. Most British Columbians take the use of these lands for granted, assuming that their use opportunities will always exist. However most people do not realize that the land base is not secure. In fact the provincial government has never developed a policy which would uphold retention of important resource lands in public ownership or a land use plan or strategy which would provide the basis for an improved system of resource management planning.

Perhaps this problematical situation on public lands in British Columbia is not unique. Certainly the Province does not suffer from the same sort of complicated, multiple ownership of lands prevalent in the western United States or the overlapping jurisdictions of federal and state administrations. Also the Province's harsh climate and geography limit land use options greatly simplifying the resource management equation. Superficially at least, the situation in British Columbia could be more readily resolved and the considerable energies spent in conflict and debate could be channelled towards developing commonly shared or non-conflicting goals and in resolving technical problems of public resource management in the Province.

STRATEGIC AND OPERATIONAL PLANNING

It is important to distinguish between strategic land use planning and operational resource management planning. These terms, strategic and operational and land use and resource management, refer to the two basic levels of planning and are not mere planners' jargon. Strategic land use plans establish which land uses and how much of each use can and ultimately will be produced on a given planning unit. Although the data that are fed into the decision-making process may be edited, collated and analyzed by public employees and private consultants, the ultimate decisions as to where and how much are political.

Operational planning, such as coordinated resource management planning, must follow from official land use plans and strategies such as the East Kootenay Trench Plan as it is the operational CRMP which sets out how and by whom the goals identified in the strategic land use plan are to be achieved (Anderson, 1977). Because CRMP is essentially operational planning at the tree falling, cattle grazing, shrub burning, dirt moving level, the implementation of an operational plan in the absence of a land use plan or strategy will ultimately lead to conflict and controversy.

This is the stage upon which CRMP was introduced to the East Kootenay Region in British Columbia in June 1975 and which led to conflict and controversy between resource agencies and uses after the benefits of CRMP first began to appear (Demarchi, 1988). Despite these shortcomings and the controversies which occurred, the benefits of CRMP are significant and would have been even greater if introduced after a land use strategy such as the East Kootenay Trench Plan had been adopted

by senior government.

The CRMP process, as well as defining the individual agency goals and objectives for distinct units of land, provided a forum whereby provincial government resource planners and managers could exchange information and resolve issues before they were escalated to senior bureaucratic or even political levels. Licenced and permitted resource users such as loggers and grazing permittees were included in the planning process thus removing a major obstacle toward integrated resource management - that of creating political issues of minor events by making decisons regarding public resources without consulting with the authorized users.

However, major political decisions such as how much of each resource product was to be produced were not made. As yields of forage, wood fibre and wildlife began to improve along with new grazing, logging and big game hunting opportunities, demands for these resources once again began to increase. The tendency of most resource managers is to try to maximize the yield of the particular resource that they are paid to manage while specific resource user and advocacy groups seek to maximize their share without concern for the impacts that their activities and demands have on others. The "tragedy of the commons" began to repeat itself as the various resource factions began to lobby for an increased share of the improved, expanded resource pie (Hardin, 1968).

In the absence of an official land use strategy the fabric of CRMP consisted mainly of good will between resource managers and licenced users. Often cooperation sprung from the recognition of common problems or common adversaries and not from any formal recognition or acceptance of each other's resource production objectives or commitments. A fortuitous combination of personalities forged CRMP in the absence of an official land use strategy but once the inital euphoria wore off it was insufficient to keep it functioning at the same level.

CONCLUSION

That a strategic land use plan was prerequisite to achieving proper inegration and management of public renewable resources was, unfortunately, not apparent at the onset of CRMP. In the absence of provincial or regional goals for timber, or forage for livestock, or habitat for wildlife, it was necessary to assume the status quo. Resource compromise decisions were deferred indefinitely thus ensuring that mainly local interests and not necessarily provincial values or interests would prevail. Objective economic cost: benefit analysis were considered but affected the outcome of each CRMP only in minor, benign ways. In some instances on some land units this ensured the continuation of marginal activities at the expense of more economically viable alternatives.

There are some dangers and some pitfalls to consider. While strategic planning at both the provincial and regional level could provide significant benefits, inflexible, rigid plans would not. Built-in flexibility which provided for changes in public demands and attitudes would increase their acceptibility to elected politicians and reduce

bureaucratic rigidity. At the same time it is obvious that most of the hard land use decisions in British Columbia have been made by nature as most of the Province's land uses are constrained by geography and climate which are often limiting to severely limiting. However, not all resource sectors would benefit from such planning - particularly those such as mining which presently have nearly a free rein to prospect and explore all but a tiny fraction of excluded lands in the Province (i.e. National and most Provincial parks).

All planning requires compromises and strategic land use planning is no exception. For wildlife interests the compromises may mean fewer wildlife overall or fewer of one species than another. To livestock interests, the costs may be in the form of shorter grazing seasons, fewer permitted livestock or increased herding to accomodate special grazing regimes. To timber interests it may mean reduced annual cut levels to acccomodate longer rotations or deferments for habitat protection. The benefits, however outweigh the costs primarily in the form of resource base protection and improved management of all resources.

To summarize, strategic planning is a prerequisite to operational planning. In the east Kootenay we got it backwards but unlike the remainder of British Columbia, at least we did it. Now you have an example of what to do and how to do it.

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INTEGRATED RESOURCE MANAGEMENT IN THE KOOTENAYS: A FOREST INDUSTRY PERSPECTIVE WITH EXAMPLES OF SUCCESS

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ABSTRACT

The objective of our company, like all other forest industries in the province is to maintain a supply of timber that will keep our mills operating. As a consequence, we often find ourselves in the middle of disagreements between various government agencies and/or user groups that restricts, reduces or threatens to eliminate our supply of wood.

To deal postively with the situation, we entered negotiations with both government agencies and the public, modifing plans where it was necessary to protect wildlife, watershed, or other values. Examples of several integrated resource management initiatives in which we participated, provide evidence that problems appearing at first to be win/loose confrontations, can be turned into win/win situations using this process.

INTRODUCTION

When our company started negotiating for integrated Forestry/Wildlife Management in the Kootenays our principal goal was to develop and maintain access to a regular supply of timber to keep our three sawmills, one veneer plant and our pulp mill operating. This goal, I suggest, was the same for all forest companies in the province. This goal is as important to Crestbrook Forest Industries now as it was in the past and I expect it to be as important in the future. Achieving this objective while accommodating the expectations of other forest resource users, required sincere involvement in the management decision making process which we and others within the forest industry had never before experienced - it was to become a "whole new ball game".

As the major users of the forest resource we were continuously mired in the middle of confrontations between the Ministry of Forests, other government resource agencies and their user groups. As an example, the Ministry of Environment, insisted that some snags be left standing to provide food and shelter for cavity nesting birds, birds of prey and small mammals. The Workman's Compensation Board demanded that all snags be felled to ensure a safe work place for our forest workers. The protection division of the Ministry of Forests wanted the snags felled because they were a very real threat to a forest due to their lighting prone presence.

It became very obvious that a procedure was required to deal with the new and complicated issues, but how it would function and where it would fit into the overall

scheme of things were as much a problem for government agencies and the public as it was for our company.

INTEGRATED MANAGEMENT

Crestbrook had always been aware of the impacts of timber harvesting on Wildlife. In particular such species as moose, elk, deer, grizzles and mountain caribou. Our company officially acknowledged this impact and asserted its responsibilities towards wildlife in a policy statement which appeared in Management Working Plan No. 4 for Tree Farm Licence #14 (TFL #14) 1972. It states, "In our opinion game populations will be enhanced if managed. As game populations are limited by winter range, artificial wintering range is developed, in part, by logging lower elevation timber stands". I would also like to emphasize that instead of receiving support or acknowledgement from the resource management agencies and the public for introducing forest harvesting methods and prescriptions which were beneficial to wildlife, Crestbrook was usually criticized for carrying out forest activities which were counter to the various ministry policies.

The above comments are not intended as criticisms, however, I must state that a combination of mistrust, misunderstanding and institutional squabbling which occurred at that time made it nearly impossible for anyone to recognize all but the obvious benefits of well planned forest harvesting prescriptions. We were often "damned if we did and damned if we didn't". In retrospect we were attempting to serve too many masters, including our senior management, bankers and shareholders. It was a difficult time then and still is today.

Demands on the forest land base were onerous. It seemed everybody wanted something. Timber for our mills, clean water teeming with trout, places for wildlife to hide, feed and breed, landscape for viewing wilderness, recreation, and cutovers, "yes" cutovers, to turn cattle onto.

Our first serious planning attempts began in 1973/74 by assembling resource information for all harvesting areas. We prepared resource folios which included forest, recreation, agriculture and wildlife capabilities based on standards used by the Canada Land Inventory (CLI). Forest inventory data was mapped along with specific wildlife habitat considerations. These resource folios helped to identify problem areas, but more importantly, they brought us all together to look for solutions and to discuss each other's concerns. These face to face encounters were the beginnings of communications which enabled us to build the trust and understanding essential in developing an integrated planning process.

We were forced to examine forest harvesting prescriptions and opt for methods which would benefit wildlife wherever possible. To do this with any confidence required thinking "Ecosystematically". This type of thinking led us to look for the beneficial factors instead of belaboring the bad. We worked from a positive rather than a negative mind set. Planning had become a worthwhile experience.

Coordinated Resource Management Planning

In 1975 coordinated resource management planning (CRMP) was started and although it had a predominantly range management focus the planning process brought us all together in a formal procedure. Within a year the procedure was institutionalized. Forest planners, ranchers, loggers, hunters and fishermen and their government agency couterparts were working together toward integrating their management goals. Public involvement became a new and important step toward managing and using the public or crown resources.

Pine Beattle Infestation

However, while we were building new institutional relationships, natural forces were at work. During the late 1960's and early 1970's major outbreaks of rocky mountain pine beetle erupted throughout the marture lodgepole pine forests of the Pacific northwest including southeast British Columbia. Particularly hard hit were the large stands of lodgepole pine located in the Kootenay, White and Flathead rivers located in the east Kootenay. Extensive salvage operations were undertaken so timber harvests increased substantially. Environmental concerns increased as well. The question of impacts to fish and wildlife were raised with every new salvage effort.

Large clear cuts appeared, much as they might have if the dead and dying timber had been damaged by wildfire. However, contrary to many of the concerns raised at the time, the results of our increased harvesting activites were either much more beneficial to wildlife than expected or had a generally neutral impact. For the most part, the stands harvested occurred in the dry montane spruce zone (MSA) and dry Engleman Spruce Sub alpine Fir Zone (ESSFa). It was also possible to break up the large configuration of cutovers by leaving stands of residual fir, larch and immature stands of unaffected lodgepole pine and spruce.

During the same period, a new system of ungulate management was introduced by the Ministry of Environment. This management scheme coincided with both the major lodgepole pine salvage and new range management programs of the Ministry of Forests. These new management programs resulted in pronounced increases in elk populations and noticeable increases in moose and deer populations.

The Blewett Watershed

During the mid 1970's with forest planning strained to its limit Crestbrook announced its intention to investigate forest harvesting opportunities in the Blewett area southwest of Nelson. The immediate response to our intention to harvest timber within the Blewett area met with very loud opposition, which was expressed at open public information meetings. Crestbrook's planning staff had now entered into a new unfamiliar planning process.

With the formation of the Blewett watershed committee chaired by Dr. Bruce Fraser, a process of communication was established involving the residents of the

community, various government agencies and industry. The public involvement planning process became the major factor that changed a very negative attitude to a positive attitude toward forest harvesting with the watershed area. In addition to the public involvement process, Crestbrook gave complete assurance to the water users of the area that any impact on the water quality and quantity caused by timber harvesting would be the full responsibility of the company. Crestbrook committed itself to total responsibility and accountability. The result was that timber harvesting and post harvesting activities occurred as planned and these activites continue to this time.

1985 Forest Fires

In 1985 another major natural event struck the east kootenay which impacted heavily on the forest and wildlife resources. Large wildfires swept through seven major drainages east and west of Canal Flats. Hardest hit were the Coyote/Lussier, Blackfoot, North White, Sandown/Findlay, Skookumchuck and Matthew Creek drainages. Approximately fifty thousand hectares (125,000 acres) were severely damaged. Again Crestbrook embarked upon a major salvage program in an attempt to minimize the loss of a valuable timber resorce. However, unlike our major Rocky Mountain Pine Beetle Salvage Program during the late 1960's and 1970's these huge cutovers were the direct result of wildfires. Beneficial gains to wildlife, expecially elk, moose and deer of these salvage operations, however, were similar to those of the beetle salvage operations.

The Trench Plan

The Trench Integrated Renewable Resource Management Plan is another land use planning process that involves a wide variety and number of other forest user groups. Although the "Trench Plan" is basically intended to stratify forestry, wildlife and range management priorities, other resource users such as agriculture, recreational camping, fishing, hunting, trapping and rural development must be considered as well.

From a Forest Industry (Crestbrook) perspective our planning staff supports a planning process that provides integrated resource management direction for renewable resource management. Crestbrook welcomes a process that allows for an efficient referral system that concentrates on operational specifics, that minimizes negative impacts, and that supports positive gains for other forest resource users.

The Trench Plan area constitutes only 7.0% of the net land base of the Cranbrook timber supply area, therefore, the potential impact on the allowable annual cut is expected to be negligible and the benefits to the other forest resource users are expected to be considerable. Although the Trench Plan is the result of an inter-agency planning process, the forest industry will review the document and, if necessary suggest changes.

CONCLUSION

By using the pine beetle infestation situation, the Blewett Watershed situation, the 1985 fire situation and lastly, the Trench Integrated Renewable Resource Management Plan, I have attempted to explain how Crestbrook becomes involved in harvesting operations that are the result of natural events and also how we deal with integrated resource management planning. Both Government and public pressures over the past twenty years have had major influences on our harvesting activities and I suggest these pressures will increase in the immediate future.

Our major concern back in the 1960's was to secure the forest land base making certain that whatever we did with timber havesting and the timber resource, there would always be left in place, a healthy productive forest ecosystem, which would produce timber, wildlife and recreational pursuits for our children and theirs.

Assurance of timber supply has always been threatened by natural forces like insects, disease and wildfire, but it is now threatened by increasing demands for more recreational use rather than industrial uses.

In the past we all worked together in developing a positive planning process to achieve economic and social benefits from timber harvesting activities. Today (1990) we see the emergence of a strong, negative sentiment from a public which seems unwilling to accept timber harvesting regardless of the benefits created for wildlife and other outdoor pursuits.

Our company continues to financially support research projects that are specifically aimed at forestry, wildlife and fisheries. Several projects completed and ongoing include; Elk Creek - Elk/logging study, Flathead River - Canadian Border Grizzly Bear Study Selkirk Mountain Caribou Study, Whiteswan/Alice's Lake, Whitetail Lake, and Cherry Lake Spawning Channel Development. In addition, recreational projects are also undertaken throughout our operating areas. They include construction and establishiment of boat launching ramps, fishing docks and camp sites.

Integrated Resource Management Planning (IRMP) which has, to a large exent replaced coordinated Resource Management Planning (CRMP) for almost ten (10) years, may not be adequate in coordinating or meeting all of the expectations we have for or from our forest land base. Nevertheless, Crestbrook is proud of its successes and achievements in the integration of Forestry, Wildlife and Recreational Management within our provincial forests.

Crestbrook is fully committed to the wise use of the Public's forest resource and will continue to participate with both the public and Government agencies in the integration of forestry , wildlife, recreation and other forest uses, so long as the end results are both ecologically and economically sound.

PERSPECTIVES ON INTEGRATED MANAGEMENT

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ABSTRACT

As a result of six years of hard struggle, the Wildlife Branch managed to convince the Ministry of Forests to defer logging on 32,000 ha for the benefit of the Itcha-Ilqachuz cariboo herd, but this meets the winter range requirement of less than half the population. Suggestions by timber interests that intensive forestry practices can increase the volume of timber cut annually by fifty percent are based on assumptions that show a total disregard for wildlife and other values. To be viable, a process integrating the management of timber and wildlife values must provide a level playing field where wildlife values are considered before timber and or pulpwood harvesting tenures are allocated, and in which timber managers attitudes towards wildlife and other values are improved.

INTRODUCTION

Symposia on integrated management have been conducted in B.C. for almost 20 years. The presentations I have made during that time period have identified and emphasized the mature timber requirements of various wildlife species. However, many of the comments I made at the earlier workshops and many of the problems I identified are still applicable today.

Success has been defined as a favourable or satisfactory outcome. In most cases, the outcome is satisfactory to one party, the Forest Managers, but not necessarily to all parties. Successful integration should be defined as the ability to meet the requirements of the various resources, including wildlife species or complements of species.

LEVEL OF INTEGRATION

The biology, management and planning for the Itcha-Ilgachuz caribou herd demonstrates the relative success of integrated management procedures and policy.

Within the Quesnel Timber Supply Area (TSA) there are approximatley 900,000 ha. of merchantable timber. The TSA planning process identified a special management area in which no logging would occur for 20 years, or indefinitely if information supported continuing the deferral. This special management area includes only 14,000 ha. of merchantable timber and results in a 1.6% reduction in the allowable annual cut (AAC) within the Quesnel TSA.

The Williams Lake TSA plan includes a proposed special management area which excludes 120,000 ha. from timber harvesting activities. This area includes

18,000 ha. of merchantable timber, and accounts for a 1.6% AAC reduction in the Williams Lake TSA.

As a result of these deferrals, four questions could be asked:

1. Was the planning process a success?

2. Is this integrated management?

3. Did we meet the requirements of the main wildlife species?

4. Did we meet the needs of species biodiversity.

The Itcha-Ilgachuz caribou herd has specific seasonal habitat requirements. The special management or features area accounts for the majority of calving, rutting and summer range. However, under the exisiting integrated management system, only 25 to 50% of the winter range requirements have been protected. There has been extensive logging throughout the winter range and future proposed logging will continue to alienate winter range habitat.

The existing deferral of 32,000 ha. of merchantable timber from the Williams Lake and Quesnel TSAs provides approximately 21 ha/caribou/winter (1500 caribou). This does not include areas of wetland lichen production, forest terrestrial lichen production or non-merchantable forest lichen production which may also provide winter forrage. The special management area (100,000 ha) and the deferred area (32,000 ha) do not meet the requirements of the potential western caribou population (3000-4000 animals without the impact of wolves).

The current integrated management process provides a very crude estimate of the carrying capacity of the area. Requirements for mature timber and arboreal and terrestrial lichen production complicate the process significantly. By comparison, logging in the East Kootenay region of B.C., with the associated production of successional stages and resultant increase in elk production, is a much simpler situation and could probably be accomplished with many different cut patterns and cutting rates. Under a regime of mild winters, the results of different timber harvesting scenarios would probably be similar and even if they were different, we probably couldn't measure the difference in numbers of elk anyway.

Within the special management areas of the Quesnel and Williams Lake TSA's have the needs of biodiversity been met? The ingegrated management prescriptions have met some or most of the needs of marten, fisher, lynx, moose and wolverine. Many of the needs of grizzly bear, marten and fisher have not been met due to activities surrounding the immedicate boundary.

In a recent provincial trapper questionnaire, habitat was listed as declining significantly in the central interior for <u>all</u> fur bearers, except coyote and wolf. Logging was listed as the main cause of the decline in all cases.

Although, this management process addressed some of the winter range

requirements of caribou and some of the needs of biodiversity, it took 6 hard years to reach this point. The Wildlife Branch was not asked to participate fully on the working group of the TSA. It had to lobby, argue and fight to achieve a full position in the discussions. Similarly, there was little, if any public involvement during the first five years of the process. As controversy developed around the Itcha-Ootsa-Blackwater area, the need for public input was at least recognized. This controversy resulted in the Dean and Blackwater LRUP's.

On the positive side; there was an opportunity to educate many foresters regarding the needs of wildlife and to realize that much of their data for this area is just as inadequate as ours or more so. After spending a day discussing age-volume curves for the west Chilcotin and switching the net down from 70% to 30%, you soon realize that a 1.6% AAC reduction is relatively insignificant in the entire scheme of forest management.

Since some form of timber commitment or tenure is granted first while other resource users are only asked for recommendations, the inequities of the TSA planning process became patently obvious. In fact, while the TSA options were being examined by the Chief Forester, the Ministry of Forests was in the process of allotting pulp agreement 19 which ovelapped most of the TSA planning area. In the current "integrated management process" the question was not "should there be a P.A. 19 in this area following proper planning"; rather, the question was "who should we give the pulp agreement to, Cariboo Fibreboard or Skeena Cellulose.

PROCESS

Currently there is no legislated protection (O.I.C.) for the Itcha special management area. It was originally proposed as a Wildlife management area (W.M.A.), while in the later stages of discussion it has been considered as a wilderness area candidate. Although Ministry of Environment and Forest staff generally agree that the best and highest use relates to the wildlife values of the area, the present Regional Manager has suggested that he will either block or not support its status as a W.M.A.

Thus, although some of the seasonal requirements of caribou have been protected, current integrated management procedures have not yet insured that the requirements of this population have been met.

On a provincial scale, it is difficult to decide whether integrated management really exists when the Cariboo Lumber Manufacturers Association states that: the study (S.F.U. wilderness study) ignores the impact of "withdrawal of available mature stands of timber (3.5% AAC reduction in Prov.) where the industry would have to operate while awaiting regrowth".

M. Apsey and the Science Council of B.C. are stating that with 100 million dollars/year they can increase the AAC by 50% in 30 years. The token statements about protecting the environment while increasing the AAC by 50% show a <u>complete</u> lack of understanding about the requirements of wildlife and other resource users.

To complicate matters even further, a recent forest symposium at the University

of B.C. stressed the need to increase the complexity of managed forests. They suggested that, "native species diversity would be maintained only if managed plantations contained the structural features typical of natural forests" (uneven aged, snags, deadfall, fungi, etc.). This obviously means a drastic change in the rate of cut, harvesting procedures and forest management in general.

Some more advanced foresters, are finally suggesting that "until this is done, representative tracts of natural young, mature and old growth forest should be retained. Although it took until 1990 for foresters to make these statements, there may be sufficient time for it to filter down through the ranks.

CONCLUSION

If integrated management is ever going to be successful, there must be several changes to the process.

1. The playing field must level out. There should be a resource impact assessment prior to issuing a commitment in the form of tenure, not after tenure has been granted. There should be no more P.A. 19's overlapping TSA planning areas, unless planning incorporates them properly.

2. Timber managers must be educated and their attitudes toward wildlife and other resource users must change.

3. Legislation and policy must provide the opportunity to make decisions, where it is warranted, which favour high value wildlife populations and habitat.

At present, as decisions move to higher levels, it becomes increasingly difficult to make decisions which do not favour timber harvesting. This occurs because resource comparisons are difficult to assess and foresters make decisions in favour of their bias. Also, without proper policy and legislation, political and industrial pressure can be severe.

I would like to end with a quotation from the Haida Nation, which was borrowed by John Turner and more recently by Sheila Copps during her campaign speech in Vancouver:

"We have not inherited the forests from our ancestors - we have borrowed them from our children".

PERSPECTIVES ON SUCCESSFUL INTEGRATION

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ABSTRACT

The planning committee for the Williams Lake Timber Supply Area Analysis was successful in integrating the requirements for Critical Mule Deer winter range into the timber supply analysis. The solution involved identifying critical ranges and changing the timber management system to protect the attributes required for winter range. The result was a reduction in annual allowable cut of 60,000 m3 and maintenance of a population of 12,000 mule deer. The participants accepted this as a reasonable integration of two conflicting requirements.

INTRODUCTION

Having lived and worked in the forest of one area of the province for 20 years provides a person with the opportunity to watch the normal cycles of "Mother Nature". It makes one realize that a manager of any natural resource must work with "Mother Nature" to achieve any level of management. Nature has the ultimate control over natural resources and we as managers can only try to influence, or direct these natural controls. For example, in the Cariboo during the late 1970's and early 1980's we had a major Mountain Pine Beetle outbreak. The forest resource managers in both the ministry and industry attacked this problem with all the expertise and money they could muster. It was a major battle. However, in the end it was two unseasonably early frosts which killed off the beetles and solved the problem. I am certain that the effort of forest managers reduced the potential impact of the epidemic but ultimately it was "Mother Nature" that controlled it. Nature also ultimately controls wildlife populations, for example, my daughter gave me Cyril Shelford's book for Christmas and in it he describes two periods when there were very few game animals. He describes a trip made by Simpson, a Hudson's Bay trader. In 1806 Simpson journeyed by canoe from Fort St. James to Williams Lake and back. They never saw a game animal on the whole trip. This is hard to imagine. Again in the early 1900's when Shelford's parents homesteaded on Oosta Lake there were no game animals and they lived on fish. This is the same time that the large elk herds disappeared from the Chilcotin Plateau. Shelford blames wolves for both these major declines in wildlife populations.

The point I am trying to make is that as resource managers, we manage as best we can with the best knowledge available, but ultimately "Mother Nature" has the final say in our success or failures.

INTEGRATING WILDLIFE AND TIMBER MANAGEMENT IN THE CARIBOO REGION

Keeping in mind our ability to influence natural populations, I would now like to describe what I consider to be an example of successful integration of Mule deer winter range requirements into the Williams Lake Timber Supply Area Analysis.

First I should describe the requirements of a mule deer winter range. They are: mature Douglas fir, South or West facing slopes, and light or moderate snow fall.

Mature Douglas fir is critical for winter ranges because it provides both snow interception and feed. The large crowns maximize the interception of snow and at the same time breakage from the upper crown provides an important part of the winter diet for Mule deer. Douglas fir is also a valuable commercial tree species and thus the conflict between forestry and wildlife develops.

Winter range is critical for the maintenance of the Mule deer population. These ranges provide winter areas for a deer population that covers a large area during the summer. Deer from Knife Creek, which is close to Highway 97, travel as far as Wells Grey Park in summer, and deer that winter near the Fraser River travel as far as Coast Mountains in the summer. The summer range for some deer is only twenty miles from their winter range. These relatively small winter ranges are critical to the survival of a deer population that is widely distributed in summer.

When producing the second five year plan for the Williams Lake Timber Supply Area, a planning committee was formed to direct the timber analysis. This committee had representatives from the Ministry of Forests, Ministry of Environment (Fish and Wildlife), and timber licensees. The planning committee decided to plan for the maintenance of critical Mule deer winter range. This was accomplished by identifying 28 critical ranges that would be managed to maintain the essential requirements of winter range. For planning purposes, they were to be managed on a 250 year rotation rather than 120 which is optimum for timber yield. This shouid maintain winter ranges while providing a reduced timber harvest. The impact on the long run sustainable yield for the Williams Lake timber supply area was approximately 2%. It doesn't sound like much, but it represents 60,000 m3 of annual harvest. This represents approximately 60 full time jobs in forestry, logging, hauling, and milling. A significant but acceptable trade-off for maintanance of a population of 10,000 to 12,000 mule deer. There was also a commitment made during the plannning process to develop a detailed management plan for each of the twenty eight critical winter ranges. These plans are to be developed jointly by the Timber Supply Area Planning committee with the Ministry of Environment being the lead agency. These plans are now being produced.

Why did it work? This is an interesting question. For the past 20 years timber harvesting in Mule deer winter ranges has been an ongoing battle. Why, after 20 years was it resolved? I think it was for the following reasons: the Ministry of Forests hired a researcher, Harold Armleder, to research the interaction of forestry and winter range. This produced information on deer use of winter range and the movements to and from summer ranges. This information was accepted by forestry and wildlife people. Harold also conducted research on levels of harvesting in winter ranges to

study the impact of light partial cuts on capability of winter ranges. This research lead to the, "Handbook for Timber and Mule deer Management Co-ordination on Winter Ranges in the Cariboo Forest Region". It was Harold Armleder's research that convinced forest managers of the critical importance of the winter ranges to the survival of Mule Deer populations. His research on harvesting impacts also paved the way for a compromise solution.

Jeanne Halleran [Conference Facilitator] asked me to address four specific points in my presentation. I would like to summarize these points:

1. The initial problem of integrating Mule Deer Winter Range into Timber Supply Area Analysis was the lack of data that was acceptable to managers of the conflicting resources.

2. The lack of data was resolved by mutually acceptable research which addressed both the problem and possible solutions.

3. At the T.S.A. Planning level there was no formal mechanism for public involvement other than the ministry of Forests & Environment mandate to represent the public. Public involvement at the T.S.A. Planning level would be very difficult because it is a very technical process and involves theory rather than on the ground decisions. Public involvement would be more productive at the individual winter range plan stage where the impacts on other users such as trappers, grazing permittees, guide outfitters, fish and game clubs, community associations, etc. should be incorporated into the plan.

4. There is no simple solution for conflict resolution. Resolutions of conflict have a much better chance of successful field implementation if people who implement them in the field are involved in resolution process. Forced resolutions that field people think are unreasonable and unworkable will not be successfully implemented.

CONCLUSION

When he was District Forester at Prince George, Bill Young had a successful method for resolving disputes. He would call the disputing parties into his office to discuss the problems. He would describe the consequences of not resolving the problem. He would then lock the combatants in a room and not let them out until a resolution was reached. It worked well in that era.

I think the best solutions to conflict will be found at the local field level rather than at a high administrative level. Land use conflicts tend to disappear when the disputing parties are actually standing discussing the problem on the ground at the site of the dispute.

Thank you for listening to my presentation. I am firmly convinced that there is room for all resource users on the same land base and that integration is the key to success.

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PERSPECTIVE ON INTEGRATION OF FORESTRY AND WILDLIFE RESOURCES

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ABSTRACT

The principal difficulty facing integrated resource management in British Columbia is the attitude of individuals participating in the process. Success requires the observation of ten rules of behaviour, which are listed.

INTRODUCTION

The watershed of the upper Blackwater river is rich in a variety of values. This drainage contains a world class canoe route, excellent opportunities for guided and unguided angling, heritage sites that are of particular importance to native people, wildlife, and timber values that, while significant, are subordinate to other values. In order to reduce conflicts in the area, we developed the "Upper Blackwater Local Resource Use Plan".

LOCAL RESOURCE USE PLANNING

Our challenge was to develop a Local Resource Use plan that all users would buy-in to, starting from a position of mistrust by most participants. The administrative framework that we worked within was the Local Resource Use Planning process. This lead to the development of a "Special Emphasis Area" that will be presented to the Chief Forester for his consideration during the 1991 re-analysis of the Prince George Timber Supply Area. I believe we have been successful in this and now have a draft plan ready for full public input which has been endorsed in principle by the planning team.

As I look forward to the development of more difficult plans in our district I believe it is important to start with some of the simpler areas and move forward, building upon success. I foresee Local Resource Use Plans someday over the entire district with the emphasis in each one reflecting the values in the zone. In our district the emphasis may switch from recreation, to range, to woodfibre.

I have a few words for all of you who believe timber is the only resource that pays this Province's bills. The 1990s' will insist that the so called other resources get their equal share of attention - because the public is demanding it.

Now for those Fish and Wildlife managers who are smugly nodding your approval out there. I remind you that the days of developing wildlife management

plans and lake stocking programs without referral to other agencies or the public are over. We must learn to live with each other, not in spite of each other.

Now on to the more complex issue of how we achieved success in our situation:

RULES FOR INTEGRATED MANAGEMENT

1. Listen to what people have say even (or especially) when it conflicts with your own goals or values.

2. Know enough about the values to respect them and converse intelligently about them.

3. Trust others to be experts in their respective fields and encourage people to stay within their areas of expertise.

4. The chairman must be genuinely committed to making the process work and must enter into it in a whole hearted and honest manner.

5. Work towards "Informed Concensus" where everyone feels responsibilty to produce a workable plan.

6. The Forest Service or anyone else chairing the planning session must be as well prepared as possible with maps, air photos, inventory and stenographic service. All stakeholders should be encouraged to be well prepared.

7. Success can be attributed to good communication which encourages everyone to work on, buy-in and become part of the plan.

8. As many of us here are managers I direct this at you:

   - encourage innovation
   - encourage risk taking
   - encourage high performance standards

9. Be open during the process and be willing to be wiser today than you were yesterday - in other words, be ready to change if appropriate.

10. Be willing to recommend trade-offs to Government. I for one believe that we as informed professionals are in the best position to recommend solutions.

CONCLUSION

In conclusion, I would like to speak to the issue of how conflicts should be resolved in the event all of the aforementioned does not work.

The Standing Forest Resources Commission struck by the previous Minister has been given the task of recommending solutions in these difficult situations. I believe that they can resolve most issues and their current course of action involving calling for public input and holding public hearings is commendable. It is very important that they move expeditiously as they need some successes so as to be seen by the public at large to be the solution to these issues.

An optimistic viewpoint I admit, but one that we are moving toward fulfilling.